Finitude, Possibility, Dimensionality: Aesthetics after Complexity

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Acknowledgments

Abstract

This thesis proposes a reconceptualisation of aesthetics moving from the irreversibility of emergence as described by the theory of complexity. Existing aesthetic platforms reflect a binary ontology that perpetuates the oppositions of concept and object or discourse and practice, thus projecting aesthetics as a contingent surface. The metaphysical split of material and immaterial is therefore maintained as the ultimate structure of sense and the sensual is still represented as the other of reason. This produces a dichotomy where art is either identified with a medium or a technology or is approached as a hermeneutical exercise that anesthetises its poetic modes of operation, thereby drifting towards visual communication.

The thesis turns to complexity theory for an alternative ontological approach that can overcome the need for such metaphysical a priori structures. Indeed, complexity offers forms of coherence that install sense locally and heterogeneously, without the possibility of universalisation. This recasts aesthetics as a cohesive surface or genetic logic, rather than mere phenomenological appearance as the image of an object or the body of a concept.

Thus, the thesis exhorts not to seek or think the ultimate, but to dwell in the finite pattern of possibility laid out by the radical irreducibility of the processes of emergence. In this light, the relation of concept and object can be re-thought as a continuum; a rhizomatic pattern of organisation that, however, no longer relies on the transcendental move adopted by Deleuze, or on Heidegger's infamous leap out of metaphysics. In fact, the thesis shows that metaphysics is not the purveyor of dimensions, but is itself a dimension of thought. Hence, the move towards Prigogine, Stengers, Barad, and Golding in order to re-articulate the structure that supports sense as the local interference of continua, or ontological segments, rather than external coordinates. This radical materialism or dimensionality names a regime beyond transcendence and immanence where aesthetics is inseparable from ontology and offers a wholly different way to think and practice art - one best understood as diffraction.

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Chapter 1: Introduction

1.1 Art and Ontology

This thesis began as an investigation into the concept of *possibility* and its relation to *aesthetics* seen through the prism of complexity and chaos theories. This stems from a fundamental dissatisfaction with the existing discourses around art, which led to seeking an alternative logic capable of speaking to contemporary art practices outside the usual tropes of a supposed opposition between reason and the senses.[1] Possibility has been related to art negatively via the problem of choice, as the source of the *anxiety* it may induce (as it was for Kierkegaard), or at best as the *sublime* experience when encountering an infinite totality.[2] Both approaches interpret the possible within a paradigm of transcendent or transcendental totality that pre-exists the act of choosing. The thesis wants to move away from such psychological profiling of the artist. *Curiosity* is the positive engine of creativity: contemporary art speculates and experiments with possibilities and it can be said to make the space in which it makes sense.[3] As one does not have "to be sad in order to be militant," so one does not have to be tormented in order to be an artist.[4]

Yet, in front of this, the existing discourses around art are stalling. Structured, as they are, by the persistent binary distribution that distinguishes object and materiality from concept and thought (a structure alternatively emphasising one or the other pole, and often

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[1] At the root, there is a personal dissatisfaction as a practicing artist with the current discourses and critical approaches that seem ultimately unable to step out of the paradigm of representation, which constantly reduces art to issues of the artist's intention and its object. This problem is engrained in the language that addresses contemporary art and is often repeated by the very structure of art education; thus amounting to an aesthetic paradigm.

[2] Cf. for example: Søren Kierkegaard, *Writings, VIII: Concept of Anxiety: A Simple Psychologically Orienting Deliberation on the Dogmatic Issue of Hereditary Sin: Concept of Anxiety*, eds. and trans. Reidar Thomte and Albert B. Anderson (Princeton, NJ, Princeton University Press, 1980); Cf. also Søren Kierkegaard, *Either/Or*, eds. and trans. Howards V. Hong and Edna H. Hong (Princeton, NJ, Princeton University Press, 1987).

[3] Curiosity as creative concept has been put forward by Sue (Johnny) Golding as both an engine for artistic and political change free from forms of a priori necessity and a fundamental trait of what it means to be human. Cf. Sue Golding, "Curiosity," in *The Eight Technologies of Otherness*, ed. Sue Golding (London: Routledge, 1997), 10-28.

[4] "Do not think that one has to be sad in order to be militant," or to be an artist. Michel Foucault, "Preface," in Gilles Deleuze and Felix Guattari, *Anti Oedipus: Capitalism and Schizophrenia,* trans. Robert Hurley, Mark Seem, and Helen R. Lane, (Minneapolis, MN: University of Minnesota Press, 2000) XI-XIV.

problematised, but never fully dispelled), they are unable to engage with contemporary practices. Aesthetics as the expression of this onto-theo-logical reductionism is forced to either perpetuate the identification of art with a given technology (hence the many media departments in art education, separated from fine art on the base of the medium); or, if there is the attempt to reject this frame, in the absence of valid analytic categories able to engage with practices that do not identify their logic with that of a given medium, art has no other option but to assume the position of a sterilised concept. Any discussion is then confined within an exclusively *hermeneutical* perimeter, which is intrinsically incapable of responding to the poetic and the sensual logics of the practice. In other words, the analytical categories adopted to discuss art-making are still trapped in the event of linear ontology, with a binary partition of the world of sense into practice and theory, unable to engage adequately with artistic practices in ways other than treating them as visual communication.

What is necessary is a radical renegotiation of the way aesthetic thinking is grasped. Yet, if this has to unseat the authority that ontology claims over sense, it must be a shift of paradigmatic magnitude. In order to formulate a concept of possibility that can respond to these questions about making sense without an a priori structure, raised from within contemporary art practices, what *Finitude, Possibility, Dimensionality: Aesthetics After Complexity* sets out to research and articulate is precisely a notion of *possibility without concept*, outside or beyond the principle of identity that heretofore has dominated its interpretation, yet without reaching to the philosophy of difference, which has constituted the only alternative so far. It will do so stepping out of ontology and taking a detour into the epistemological problems raised by the sciences of chaos and complexity, distilling a alternative logic of sense from the processes of emergence, towards a methodology able to support possibility both as the source and the material of art.

The thesis puts forward the concept of *dimensionality*, as an alternative understanding of possibility; one removed from foundational ontology (and its ever returning colonisation of sense) and free from the metaphysical overtones of identity. In

dimensionality, *dimensions and possibility converge* into a form of logic that can support the coherence of sense, yet one where dimensions are not absolute or external coordinates but process-specific patterns, and the possible is not external to the present but its shape. As it will be seen, this affords a positive image of possibility that expresses a logic of heterogeneity, site-specificity, and locality, which allows art to move past the base of anxiety or lack.

1.2 Re-Tracing Aesthetics

There is a peculiar circularity between aesthetics and art. On the one hand, aesthetics is historically related to the senses, to the appearance of the phenomenon and to the obscure and confused perceptions that modern debates opposed to the clear and distinct acts of the intellect.[5] On the other, one sees that after Kant, aesthetics individuates an isolated practice of a truth separate from engagement with historical life; the object without concept or given finality of Kantian aesthetic judgment.[6] There the pedestal of the art piece is a physical support as much as it becomes the conceptual frame of art, that which separates it from life and holds it for contemplation cementing the identification of art with its material medium.[7] The Hegelian aesthetics identifies the two, installing an image of

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[5] The problem of clear and distinct ideas versus obscure and confused perceptions was a question that animated the modern philosophical debate and has remained dormant in the conceptualisation of art through aesthetics. Cf. René Descartes, *Principles of Philosophy*, trans. John Veitch (København, DK, SNK Books, 2009) and "Meditation Two: Concerning the Nature of the Human Mind: That is Better Known than the Body," in *Discourse on Method and Meditations on First Philosophy*, trans. Donald A. Cress (Indianapolis, IN: Hackett Publishing Company, 1998), 63-68. Cf. also Gottfried Wilhelm Leibniz, *New Essays on Human Understanding*, eds. and trans. Peter Remnant and Jonathan Bennett (Cambridge: Cambridge University Press, 1996); and John Locke, *An Essay Concerning Human Understanding*. ed. Kenneth P. Winkler (Indianapolis, IN: Hackett Publishing Company, 1996).

[6] Cf. Emmanuel Kant, "Analytic of the Beautiful," in *Critique of the Power of Judgment*, ed. Paul Guyer, trans. Paul Guyer and Eric Matthews (Cambridge, Cambridge University Press, 2000), 87-127. Cf. also Jacques Ranciére, "Divided Beauty (Dresden, 1764,)" in *Aisthesis; Scenes from the Aesthetic Regime of Art*, trans. Zakir Paul (London: Verso, 2013), 1-20.

[7] Allan Kaprov has attempted blurring this boundary by moving to live happenings. Cf. Allan Kaprov, *Essays on the Blurring of Art and Life*, ed. Jeff Kelley (Berkley, CA: University of California Press, 1996). Benjamin had highlighted how such contemplation is the main trait of the classic image of art; Cf. Walter Benjamin, "The Work of Art in the Age of Mechanical Reproducibility," in *Illuminations*, ed. Hannah Arendt, trans. Harry Zorn (London: Pimlico, 1999), 211-244. It is also worth mentioning Piero Manzoni's ironic take on this paradigm with the piece *Socle du Monde* (1961), where an upside down pedestal holds the entire planet as the art piece.

art as: a) *material*, the product of a medium – from here it is easy to see how the medium becomes the logic according to which Hegel organises the hierarchy of the arts in his aesthetics; b) holding a specific and very low position in the hierarchy leading to the logic or truth (a concept to which only philosophy has a privileged access).[8] The modernist notion of medium took place within this space.[9]

Yet, even with the post-structuralist line of approach, a dualism between object and concept, or matter and discourse, is not, contrary to its supporters, dispelled; indeed, it is reinforced.[10] Art and the material-sensual are still opposed to rational language, captured, subjugated and kept in proximity as its *other;* and at the same time as that which remains forever incommensurable with logos. Art, again, does not have a position for itself, but is framed and encased by the structure of logo-centric thought or discourse (which believes itself to be disembodied and pure; ideal).

In this light, the problem with the identification of aesthetics and art – which confines the artistic practice within the description of a medium as a material or a technology - is that seeking an exit from this kind of binary divide of matter and discourse can only produce an opposition, never an alternative. Hence the *hermeneutical* interpretation of art practices mentioned above sets in, overlooking and silencing all *poetic* aspects of *poiesis*, as well as its sensuality; both of which, instead, in the practice of art belong to the object as much as to the concept. This engenders a captured or colonised space closer to a Euclidean playing

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[8] For the linear hierarchy Hegel sets up for the arts, Cf. Georg Wilhelm Friedrich Hegel, "Division of the Subject," in *Introductory Lectures on Aesthetics*, ed. Michael Inwood, trans. Bernard Bosanquet (London: Penguin, 2004), 76-97 and *The System of the Individual Arts*, *Lectures on Fine Art,* Vol. 2, trans. T. M. Knox (Oxford: Oxford University Press, 1975).

[9] Cf. Clement Greenberg, "Modernist Painting," in *Clement Greenberg: The Collected Essays and Criticism* Vol.4, ed. John O'Brian (Minneapolis, MN: University of Minnesota Press, 1993) 85-93; and "Modern and Post Modern," and "Intermedia," in *Clement Greenberg: Late Writings*, ed. Robert C. Morgan (Minneapolis, MN: University of Minnesota Press, 2007), 25-33 and 93-98.

[10] Cf. for instance Rosalind Krauss, *A Voyage to the North Sea, Art in the Age of the Post-Medium Condition* (New York, Thames and Hudson, 1999); or *Žižek*'s notion of art as a symptom, Cf. Slavoj *Žižek Sublime Object of Ideology* (London: Verso, 2002).

field, where possibility is brought to bear in the making of art either *a priori* or *a fortiori*.[11] A space where the hierarchy that Hegel had imposed via his encyclopaedic system can at best be replaced by a distinction between identity and its other, resulting in an image of art and its modes of thinking and operating always-already kept at the periphery of a thought that imposes itself as the correct and privileged method towards a centre that it has set for itself.[12]

This was already clear in Heidegger's position about art, although one can suggest that his interpretation does not provide a way out either.[13] While it is true that Heidegger identifies aesthetics as yet another form of ontological *enframing*, which relegates art to appearance and feeling, this does not guarantee that art is not captured by ontology in another form. The rejection of classic aesthetics is in favour of an image of art and poetry as a special language able to overcome the enframing of the rationality of metaphysics and speak authentically of the relation with Being, still retains the privilege of ontological abstraction at its core. By Heidegger's own admission it is impossible to escape this onto-theo-logical structure (the same argument that pits the body versus logo-centrism developed by Luce Irigaray, is another example).[14]

Hence the impasse mentioned above: either art is still identified with phenomenological appearance and the senses, or with a technology as its contemporary

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[11] The concept of *colonising* and *colonised* practices crosses transversally many works of Stengers; Cf. in particular Isabelle Stengers, "Wandering About Materialism," in Levi Bryant, Graham Harman and Nick Srnicek eds. *The Speculative Turn; Continental Materialism and Realism* (Melbourne: re.press, 2011), 368-380.

[12] Cf. Georg Wilhelm Friedrich Hegel, *Encyclopaedia of the Philosophical Sciences in Basic Outline*, eds. and trans. Klaus Brinkmann and Daniel O. Dahlstrom (Cambridge: Cambridge University Press, 2010) and *Phenomenology of Spirit*, ed. A. V. Miller (Oxford: Oxford University Press, 1977). Cf. also Hegel, *Introductory Lectures on Aesthetics*.

[13] Cf. Martin Heidegger, "The Origin of the Work of Art," in *Off The Beaten Track*, eds. and trans. Julian Young and Kenneth Haynes (Cambridge: Cambridge University Press, 2002), 1-56. Cf. also Martin Heidegger, *Identity and Difference*, trans. Joan Stambaugh (Chicago, IL: University of Chicago Press, 2002). Cf. also Martin Heidegger "The Question Concerning Technology," in *The Question Concerning Technology and Other Essays*, ed. and trans. William Lovitt (New York, NY: Harper, 1977), 3-35. Lastly, Cf. Martin Heidegger, *Poetry, Language, Thought*, trans. Albert Hofstadter, (New York, NY: Harper & Row, 1971). The problem of the onto-theological capture was admitted by Heidegger in the second lecture of *Identity and Difference.* Cf. Martin Heidegger, "The Onto-theo-logical Constitution of Metaphysics," in *Identity and Difference*, 42-74.

[14] Cf,. Luce Irigaray, *The Forgetting of Air in Martin Heidegger*, trans. Mary-Beth Mader (Austin, TX: University of Texas Press, 1999).

equivalent; or it swings to the opposite extreme of the ontological spectrum abandoning the sensuality of the object for the purity of the concept for which it simply provides an illustration. The distribution and hierarchy of ontology remains in place. Conversely, if thought can disassociate aesthetics from phenomenological appearance, perception and the senses, and renegotiate it instead emphasising art as a practice that *makes* sense in the strongest meaning of the word make, it will become possible to speak of aesthetics as *coming to presence* in radically different terms, where art is neither a transparent vehicle for an idea nor a privileged relation with an absolute possible, but rather a regime where possibility becomes art's object and also its matter. If art is to be really creative rather than representational, this possibility cannot be posed a priori of the practice. As it will be explained, this is the main claim of the thesis, the support of which will be drawn out in Chapters 2-4.

In the preface to the English edition of *Difference and Repetition*, Deleuze attempts to undo this hierarchy; that is to say, to put philosophy, science, and art on an equal footing towards sense: logics equally valid for the production of sense/truth and yet not equivalent in the way in which their diverging landscapes function.[15] Chapter 3: "The Mechanic of the Possible" will show how with the move that Deleuze and Deleuze and Guattari make - especially in light of a rhizomatic logic- the materiality of the contingent body experiences a more fluid life than under the rule of a rigid concept of non-contradiction.[16] Yet, here too there persists a structure that privileges ontological idealisation, for these practices are presented as embedded in difference as the ultimate horizon, the common denominator to all forms of presence. What seems necessary for contemporary art is to disassociate aesthetics from these ontological references: the material, body or image, opposed to the pure and idealised level of the intellectual understanding. The latter still leads to

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[15] Cf. Gilles Deleuze *Difference and Repetition*, trans. Paul Patton (London: Continuum, 2008), XIII-XV. This is the very structure of *What is Philosophy* where this move is articulated in detail; Cf. Gilles Deleuze and Felix Guattari, *What is Philosophy*, trans. Graham Burchell and Hugh Tomlison (London: Verso, 2011).

[16] Cf. Gilles Deleuze and Felix Guattari, "Rhizome," in *A Thousand Plateaus; Capitalism and Schizophrenia*, trans. Brian Massumi (Minneapolis, MN: University of Minnesota Press, 2005), 3-25.

contemplation and voids art from any real involvement with life, history and politics - keeping it within a regime of contemplation, which in contemporary culture has become a regime of consumption, still confines it to a passive form of engagement.[17] While the former (the material reduction) keeps art chained to the notion of *medium*, whichever this may be, and thereby inevitably frames it before it is made within a dualism that separates a priori what art can be from what is posed as the disembodied discourse, which the medium would embody. Disassociating aesthetics from these roots while maintaining the dialogue it has developed with the practice of art; that is, disassociating art from the image of a practice involved exclusively with the *senses* while retaining its *sensual* modes of operation, may allow renegotiating its position and the hierarchy it has among the practices of making sense.

1.3 From Materiality to Mattering and the Logics of Sense

To address this problem the thesis steps out of the structures traditionally adopted to discuss sense and finds an alternative conceptual platform in the research on complexity and statistical dynamics put forward by physicist Ilya Prigogine and the epistemological elaboration of its outcomes developed by Isabelle Stengers in collaboration with Prigogine (see Chapter 2, "Ontology Interrupted").[18] Prigogine had sought a reconceptualisation of dynamics in order to overcome the incompatibility this has with thermodynamics. This led him and Stengers to reconceptualise matter as intrinsically active and historical (hence irreducible to the axiomatic economy of sufficient reason). While this produces a major

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[17] Rancière in *The Politics of Aesthetics* addresses this separation of the artistic attention from the other practices of life. However, it would seem that his analysis should be turned on its head. What he calls the *politics* of aesthetics is not the partition that separates the practice of art and artistic experience from the rest of the world, but rather the fact the art draws such partition, as the withdrawing of artistic practice in a special area at the exclusion of the rest. Cf. Jacques Rancière, *The Politics of Aesthetics*, trans. Gabriel Rockhill (London: Continuum, 2004).

[18] Cf. Ilya Prigogine and Isabelle Stengers, *Order out of Chaos; Man's New Dialogue with Nature* (London: Harper-Collins, 1984). The new concept of matter that they introduce will be elaborated further Chapter 4: "Dimensionality: Finitude and the Roughness that Matters" in the light of Karen Barad's notion of *diffraction*; Cf. Karen Barad, *Meeting the Universe Halfway: Quantum Physics and The Entanglement of Matter and Meaning* (Durham, NC: Duke University Press, 2007).

paradigm shift for physics moving from integrability to emergence, the thesis claims that this new irreducible notion of matter in turn demands a reconceptualisation of aesthetics in radically alternative terms; that is, as *a presence that is intrinsically entangled with sense* – or an emerging present whose logic of coherence cannot be reduced to reasons that transcend its presence, and where possibility shifts from a metaphysical horizon to an irreducible and site-specific feature of the present.[19] At stake there is a shift in the understanding of *matter* and *materiality* away from the ontological paradigm of representation, reductionism and the ultimate, turning towards questions of relevance and *mattering* (which will be discussed in Chapter 4: "Dimensionality: Finitude and the Roughness that Matters").

What the thesis argues is that Prigogine and Stengers' case for irreducibility in dynamics introduces a radical *finitude* of the present. This distances itself from both the paradigm that conceives the event of sense as that grounded in foundations and that which surfs on ontological difference, and instead opens a path for disassociating *presence* from the dichotomy of *appearance* versus *essence* (or from the groundless, as its frustrated version) to link it to emerging *coherence*. Givenness cannot be abstracted from the event of its making. In fact, as will be explained, not only does the given emerge as the expression of its coherence, but such emergence is the result of an *open* process.[20] This move enables a liberation of aesthetics from the negative interpretation mentioned at the outset, where aesthetics is limited to the phenomenological surface, either as the image or the body (or both) of a concept. It will also free the surface from the image of the post-modern

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[19] Supra: as it will be seen in Chapter 2 this does not reintroduce a logic of immanence, but has instead an effect on the notion of causality.

[20] One could venture that this was the deep meaning of the self-reflective aspect of Kantian aesthetic judgment: appreciating the functioning of the logic of knowledge beyond the content or finality of such process; appreciating the logic of existence per se, so that aesthetics becomes a contemplation of ontology. Cf. Kant, *Critique of the Power of Judgment*, 87-230.

simulacrum, which only exists in the mourning of the ground it has lost; that is, with an existence forever tainted with negativity.[21]

In this light, the thesis will show how aesthetics interpreted through the prism of emergence provides a logic for presence, and yet this is not quite simply a *rhizome*. Finitude as emerging coherence cannot be assimilated to the rhizome smoothly. Indeed, in the speculative approach to sense and its logic that Deleuze and Guattari put forward (even if it is inspired by the heterogeneous combinations of evolutionary logic, replacing identity for ontological difference in the structure that supports the contingent coherence of sense) difference is still *tangent* to sense in the present. That is, the ontological passage from *nothing* to *something* is still privileged over any aesthetic or epistemological determinations; while the importance of temporality and genealogies does not receive the right emphasis and is left to the contingency of history.[22] Conversely, Prigogine and Stengers bring to the fore the importance of history in the processes of coherence, emphasising a temporal and genealogic element intrinsic to the rhizomatic logic that the visual metaphor of Deleuze and Guattari could not afford.

The speculation that Deleuze proposes retains *sufficient reason* (although in the abstract form of difference or pure possible), a position diametrically opposed by speculative realists such Meillassoux in his establishing of the principle of absolute *un-*

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[21] Cf. Jean Baudrilliard, *Simulacra and Simulation*, trans, Sheila Fariah Glaser, (Ann Arbor, MI: University of Michigan Press, 2006). Cf. also Jacques Derrida, "Plato's Pharmacy," in *The Dissemination*, ed. and trans. Barbara Johnson (London: Athlone Press, 1981), 61-119. Lastly, the entire ontological project of Deleuze points at the notion of simulacrum as a paradoxical logic of existence. In particular Cf. Deleuze, *Difference and Repetition*; and Gilles Deleuze, "The Simulacrum and Ancient Philosophy," in *The Logic of Sense,* ed. Constantin V. Boundas, trans. Mark Lester and Charles Stivale (London: Continuum, 2004), 291-320.

[22] Supra: As will be seen in Chapter 3 and 4, aesthetic and art can continue their dialogue as a generative logic, or the logic of making sense. Yet, one where sense can emerge –or be made- from different practices, none of which has a privileged position in reference to truth; in fact this notion too will shift from that of an a-temporal a priori, to one of *mattering* and *relevance* for the future. This would satisfy both the horizontal distribution of philosophy, science, and art as presented in *What is Philosophy*, and the more directly democratic notion of *parliament* of practices proposed by Stengers in *Cosmopolitics*, where truth and its object are *constructive* rather than representational or relativistic. Cf. Isabelle Stengers, "Book VII, The Curse of Tolerance," in *Cosmopolitics* Vol. 2, trans. Robert Bononno, (Minneapolis, MN: University of Minnesota Press, 2011), 303-416.

reason.[23] Whilst Meillassoux wants to discard sufficient reason, he retains the space of an a priori absolute possibility, resurrecting the Euclidean geometry that Deleuze had long rejected. Although the thesis accepts Meillassoux's proposition to a lesser degree than that of Deleuze, neither proposition is adequate.

The entirety of the argument is developed along the following three interrelated concepts of *finitude*, *possibility* and *dimensionality*. Thus, Chapter 2: "Ontology Interrupted," looks into this question of finitude by investigating the impossibility of linear ontology exposed by the problem of non-integrability, as developed by Ilya Prigogine. Here will be seen how Prigogine and Stengers develop the argument that the *continuity* between the present and the ground, or between the present and the limit, is the product of an arbitrary *idealization*. The discovery that most dynamic systems are *non-integrable* (irreducible to fundamental elements or axioms, with more than one solution possible for the same boundary conditions) bars the passage to any *totalizing* description. What the chapter will draw out from this argument is that the concept and reality of the present is both logically finite and temporally irreversible. Certainty, as the epistemological expression of the absolute, withdraws in front of probability and complexity replaces determinism, with disruptive effects for the canonical representation of reality. This constitutes the *pars destruens* of the thesis' argument.

The interruption of ontological continuity brought about by the impossibility of integration will be examined in relation to the linearity of the principle of sufficient reason and renegotiated via Mandelbrot's notion of self-constrained interpolations in fractal processes. Both highlight the importance of including temporality at fundamental level in physics as well as in ontology. This, as will be seen, raises a further problem: Prigogine's reconceptualisation of dynamics, Stengers points out, produces a *counter-actualisation* of

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[23] Meillassoux advocates a return to metaphysics by denying finitude through a rejection of all interpretations of sense on the base of correlation that have followed since Kant. Contrasting the return to the absolute that Meillassoux suggests is one of the reasons that spurred this thesis; although obviously this does not imply a return to Kant. Cf. Quentin Meillassoux, *After Finitude: An Essay on the Necessity of Contingency*, trans. Ray Brassier (London: Continuum, 2009). For the notion of "geometry of sufficient reason," Cf. Deleuze, "The Image of Thought," in *Difference and Repetition*, 162-213.

physics away from the paradigm of universality, whereby different mathematical models can be equally valid for the description of reality, and yet produce radically diverging *images* of nature and the universe. Stengers emphasizes how this leads to a reconceptualization of *epistemology*. However, the shift this presents is not between paradigms but in the notion of paradigm itself. In fact, this reconceptualization is so radical that it amounts to a new *ontological* proposal - which will be the subject of Chapter 4.

"The Mechanics of the Possible" (Chapter 3) acts as a hinge between the demise of ontological continuity shown in chapter two and the construction of an alternative logic that will be proposed in chapter four. Given the demise of identity and determinism resulting from Prigogine's work, the chapter explores and articulates how *possibility is still possible*, rather than vanishing in an abyss of chaos and arbitrariness. In the light of the logical irreducibility and temporal irreversibility introduced in chapter two, the chapter will engage anew with the notion of rhizome via the notion of emergence presented in complexity theory. The current philosophical interpretations of complexity tend to re-ontologise chaos by emphasising the image of the limit or the edge of chaos, hence one is constantly drawn back to the continuity posed between this limit and the present.[24] The thesis does not follow this assimilation of chaos with Being; rather, this chapter emphasises how the conditions that lead to chaotic behaviours constitute constraints that are necessary but not sufficient to guarantee emergence (as explained by Kauffman, Prigogine and Stengers, and Stengers), thereby introducing an *openness* in the concept of possibility, as that which allows finitude to change and evolve. This openness will lead to revisit Leibniz's concept of compossibility in the light of mathematician Gregory Chaitin's interpretation of Gödel's incompleteness.[25]

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[24] The most obvious examples are Deleuze's difference and Deleuze and Guattari's interpretation of chaos in *What is Philosophy*, Meillassoux's notion of absolute possibility in *After Finitude*, as well as Stengers' possible-virtual, or DeLanda's dualistic image of chaos-order, and Jeffrey Bell's assimilation of chaos to ontological difference. Cf. respectively: Deleuze and Guattari, *What is Philosophy*, 117-134 and 201-218; Isabelle Stengers, "Book I, The Science Wars," in *Cosmopolitics* Vol. 1, 1-86 in particular 264n1; Manuel DeLanda, "Emergence in History," in *Philosophy and Simulation: The Emergence of Synthetic Reason* (London: Continuum, 2011), 1-6; Jeffrey A. Bell, *Philosophy at the Edge of Chaos: Gilles Deleuze and the Philosophy of Difference* (Toronto: University of Toronto Press, 2007).

[25] Cf. Gregory Chaitin, *Meta Math! The Quest for Omega* (New York, NY: Vintage Books, 2006).

As a result, open finitude is interpreted as a logic of coherence, which is rigorous and yet *not universal*, a form of causality that is complex rather than linear, thus rejoining the ontological shift mentioned in the closing of chapter two.

Chapter 4: "Dimensionality: Finitude and the Roughness that Matters," as mentioned above, sets out to develop a logic of sense alternative to the solutions developed from linear ontology. The non-universality introduced by Prigogine's work on chaotic behaviours corresponds, as will be discussed, to a positive finitude of the logic of sense, which is the key for the concept of dimensionality (the *pars construens* of the argument). Free from the reduction to a common denominator (universal) the convergence of dimensions and possibilities raised at the outset of the research, displays an intrinsic creative or genetic potential. The onto-theo-logical anxiety, preoccupied with the absolute passage from *nothing* to *something*, yields to the aesthetico-epistemological creativity at play in the reason for things to be organised *thus* rather than *otherwise*.[26] In fact, finitude, as the non-integrability demonstrated by Prigogine, no longer permits to distinguish an idealised and pure presence (givenness) from the determinations of contingent existence (the given). Here, as will be shown, Stengers' critique of science, where the impossibility of universality presents knowledge neither as a *fact* nor as a *fetish*, but a *factish* (the product of the *constraints of the practice*), merges with Deleuze's notion of *genetic* concepts into dimensionality.[27]

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[26] The "onto-theo-logical" is the paradigm of transcendental idealisation that Heidegger encountered as the very syntax of language and thought and which prevents philosophy from getting rid of the enframing of metaphysics. As such, it acts as a source of anxiety well beyond Heidegger's thought. Cf. Martin Heidegger, *Identity and Difference*, 42-74.

[27] Stengers borrows the concept of *factish* from Bruno Latour. Cf. Bruno Latour, "On the Cult of the Factish Gods," in *On The Modern Cult of The Factish Gods*, trans. Catherine Porter and Heather MacLean (Durham, NC: Duke University Press, 2010), 1-66. However, for the purpose of this thesis her interpretation is much more fertile than Latour's initial idea, because it emphasises a materiality in the practice of science whose relevance for the production of knowledge is too often ignored. Science is not a transparent vehicle for truth, but is a material and a contingent *practice.* That is, the contingency of science derives from the obligations and requirements of its specific activity; even when this is the apparently disembodied and transparent language of mathematics in theoretical physics. This is the *constructive* logic that for Stengers replaces both determinism and relativism. Cf. Stengers, *Cosmopolitics*, Vol.1 1-86; for genetic concepts Cf. Deleuze, *Difference and Repetition*, 164-213.

At this point, the chapter will show how in this last turn ontology undergoes a radical reconceptualisation. The materiality intrinsic to the practice is genetic and constructs a truth valid only within the domain of its relevance. As developed in detail, this move meets with Karen Barad's concept of *diffraction*, linking sense to the question of *mattering*, instead of an expression of identity via representation. The thesis will take Barad's concept as key for the articulation of dimensionality, linking this with Stengers articulation of the notion of factish, as a central feature to a logic of *making* sense both rigorous and sensual. This, as will be argued, is a post-postmodern construction of truth, which, in as much as it supports a coming to presence, is both intrinsically aesthetic and provides a logic of making sense outside the traditional hierarchy that has kept art, science, and philosophy apart. In this light, Stengers' notion of practice provides a logic for the making of sense that responds fully to the heterogeneous logics of contemporary art. The chapter thus delves into this question of genetic finitude, showing that *dimensionality* is not repeating physical spatio-temporal dimensions; rather, it expresses fractal patterns and rhythms of iteration (Mandelbrot).[28] Traditional partitions are, in fact, *continua,* generative dimensions rather than background coordinates; they carry a history or *genealogy* that plays in their iterations and mutates over time.[29]

The thesis thus concludes that givenness is only *contingent*; finitude must not be grasped as a *differential*, but as a *positive pattern*.[30] Sense is the product of local processes, a segment of matter, experience, and history, which is finite and yet open to change; not immanent or transcendental, rather, returning to Mandelbrot, self-constrained. It is only in the finite possibilities of the given that interpolating iterations can physically get hold of a *something* (objects or thoughts). *Givenness is rough*, precisely because it is finite

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[28] Cf. Benoit Mandelbrot and Richard L. Hudson *The (Mis)Behaviour of Markets: A Fractal View of Risk, Ruin and Reward* (London: Profile Books, 2004).

[29] Genealogies is the concept that Foucault proposes to replace static frames in the interpretation of history. Cf. Michel Foucault, "Introduction" and "The Discursive Regularities," in *The Archaeology of Knowledge*, trans. Tavistok Publication (London: Routledge, 2004), 3-22 and 23-88.

[30] Contrary to Meillassoux's thesis, it is not the "necessity of contingency" that is at play here, but rather the contingency of necessity. Cf. Meillassoux, *After Finitude*.

(a pattern); it exists only in the organization and meaningful presence of sense. In turn, sense exists and behaves as finite given, rough and open. This permits explaining that 'complexity' is not adopted here as a new analytical category for the negotiation of sense outside linear ontology. The thesis does not propose an *aesthetic of complexity*; nor emergent processes constitute an analogy for artistic practices. At the same time, it would be hasty and perhaps too one-dimensional to claim instead a complexity of aesthetics, without further specifications.

Finally, the concluding remarks will emphasise how complexity and chaos theory offer a logic that permits speaking of presence in terms radically different from the representational structure imposed by the linearity of ontology. The emergence of the present is a question of non-linear and irreducible processes (complex). Presence is a notion that cannot be relegated to the surface of the ontological body. Therefore, aesthetics cannot be confined to the superficial level of a phenomenological and contingent given; rather, it goes to the core of ontology and it is indissoluble from the organization of epistemological dimensions, as well as inseparable from the image of nature, the universe, and matter that the philosopher, the scientist, and the artist adopt or project. Aesthetics is therefore reconceptualised as the product of complex systems, and in this light, it is itself complex. The key to this shift is that interrupting the linearity that poses a smooth transition between the present and the ultimate (be it reductionism or idealisation) makes the present neither reducible nor reproducible via the ground or at the limit. The surface of presence is not superficial but a *singularity* – aesthetics, as the logic of coherence of such surface, becomes the logic of sense.

And so, as we will see, the *loop* continues.

Chapter 2: Ontology Interrupted

2.1 Idealization and the Image of Thought

Ontology displays an essential *continuity* between the present and the *ultimate* (be it the classic totality, the modern ground, or the postmodern limit), which has quietly acted undetected from Descartes' ontological proof all the way to the *reduction* to difference of postmodern ontology. This smooth passage from the present to the ultimate is an *idealization* where the equivalence of cause and effect and the abstraction into the pure state at the limit merge, sharing the same *transitive* property: a *spatialised* image of thought that conceives the present and the ultimate *simultaneously* and their continuity as a priori. If this is evident in the metaphysical approaches that ground contingency in identity, the preconception of conservation and continuity necessary for this *reduction* remains partially unquestioned in the case of the ontology of difference that would like to uproot sense from the notion of ground. In his quest to re-introduce the arrow of time in dynamics, Ilya Prigogine interrupts this ontological continuity. In fact, the reducibility of a continuous and spatialised logic of Being, or the ontology that sees sense as tangent to difference, do not take into account the time and the folds necessary to reach such a horizon; both are essentially *linear*. On the other hand, a *speculation* that includes the *possible* in the definition of the present is discontinuous and undoes the limit as an ontological horizon, infinite or absolute; the former are transcendent/al, the latter *metastable*.

The present needs legitimization from the ground of the overall definition of totality or from the limit case posed as an idealized model; as the contingent presence of a metaphysical necessity it is condemned to remain *superficial* appearance, as the object that belongs to a concept, which retains all authority and reasons; most importantly this is a present that can change only along parameters already established by such necessity. Such is the realm of *aesthetics* inherited from the modern image of thought. However, when the ground melts into difference this problem is not dispelled. In fact, the logic of the

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ultimate remains: what was a solid point becomes a faceless reason, an indefinite and undecidable horizon. Reducibility is still the logic that supports the image of sense.

Prigogine shows that the fundamental *simplicity* required by this reduction is the logic of classical dynamics as well as quantum mechanics; it is also the problem implicit in posing idealization as the model for physics and for science in general. Ontology mirrors this in the image of Being. In fact, the same generalising abstraction toward pure essence, free from contingent roughness, circulated in philosophy long before the advent of modern science: from Plato's pure forms to the conservation intrinsic to linear causality or the consistency of axioms-theorems.[1] This idealization is an *image of thought* that remains unquestioned, even in the critique of a priori identity developed by Deleuze.[2] In fact, the continuity between the present and the limit, both as the abstraction towards essence or as the reduction to difference, is yet another image of thought that acts undetected, not only shaping the logic of Being and supporting the spatialised image of ontology, but preventing thought from reaching a *logic of sense*. This problem is pivotal: in the movements of actualization and counter-actualization that Deleuze opposes to the reducibility demanded by principle of identity, and which Isabelle Stengers adopts as the key to rework the image of physics, sense and difference remain immediately *tangent*.

Ilya Prigogine exposes a radical *irreducibility* in physical processes that has a direct repercussion on this image of ontology. Indeed, the concern for an image of matter that does not reduce time to phenomenological illusion does not lead Prigogine to a linear chronology, one structured by beginning and end points and in between stages, rather to one of random bifurcations and emergence. This is not simply a demise of the linearity of determinism and causality. In fact, it exposes the ideological arbitrariness of seeking the

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[1] As will be seen in this chapter, this was a fundamental element of Descartes' proof of God existence or of Leibniz's position on mechanics, and returns in the problem of consistency encountered by Gödel.

[2] Deleuze discusses the notion of *image of thought* in the third chapter of *Difference and Repetition*, as the unspoken and accepted coordinates of the stage on which thought develops. *Stage* and *coordinates* are not deleuzean concepts. It is however important to highlight how such image functions precisely as the invisible but supporting structure that organises the space in which thought acts; and *space* it is, for any ontology that tends to totalize produces a spatial image of itself, sense, and its possibilities. Cf. Gilles Deleuze, "The Image of Thought," in *Difference and Repetition*, trans. Paul Patton (London: Continuum, 2008), 164–213.

logic of the present in the *ultimate*, in fundamental elements that would sit at the limit, and thus require a liner continuity to both be reached and reach back to the present. Whether it is the case of Heidegger's groundless ground, Derrida's difference at the limit, Lyotard's thickness, or Deleuze and Guattari's rhizome, the continuity of ontology had remained inside the arguments that analyse the emergence of sense.

Perhaps there, where Stengers points out the hostile reception of Prigogine reconceptualization of dynamics and the laws of chaos, and the difficulty of creating a new scientific event that can reconceptualise the image of nature according to the new image of physics as a constructive factish;[3] perhaps there, it is philosophy that is mostly effected, because this event does not impose a new universality,[4] rather it withdraws from claiming a new truth. It is philosophy that fears the vulnerability of the "truth of the relative" (as Stengers calls the metastable logic of the emergence).[5] If physics can ignore these alternative demands and still work with approximations to keep its linear paradigm working, philosophy is instead under much more pressure to listen to them because they directly concern the image it has of itself as the logic that relates theory and practice in the

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[3] Cf. Isabelle Stengers, "The Arrow of Time" and "The Passion of the Law," in *Cosmopolitics*, Vol. 2, trans. Robert Bononno (Minneapolis, MN: University of Minnesota Press, 2011), 105–122 and 192–204.

[4] Ilya Prigogine and Isabelle Stengers co-authored two major works on the reconceptualization of physics that leads to complexity theory: *Order out of Chaos, Man new Dialogue with Nature* (London: Harper-Collins, 1984) and *Entre le Temps et l'Éternité*, (Paris: Fayard, 1988), (Between Time and Eternity). It must be noted that *Order out of Chaos* (originally titled *La nouvelle Alliance*, 1979) was considerably reworked by the authors in occasion of the English translation, to update the conclusions to the new findings at both theoretical and experimental level. The version referred to here is the English one. *Entre le Temps et l'Éternité* instead has not been translated into English. The thesis refers to the Italian translation: Cf. Ilya Prigogine and Isabelle Stengers *Tra il Tempo e L'Eternità*, trans. Carlo Tatasciore (Torino: Bollati Boringhieri, 2014). A considerably reworked version of this work, reflecting the "important progress in the mathematical formulation of our approach" was published in English authored by Prigogine alone (Stengers appears only as a collaborator), Cf. Ilya Prigogine, *The End of Certainty, Time, Chaos and the New Laws of Nature* (New York, NY: The Free Press, 1996), VII. Since *Entre le Temps et l'Éternité* highlights epistemological issues that in *The End of Certainty* leave the precedence to more technical, but no less important information, both texts appear here as separate works. Comparing the French and the English versions of Stengers' *Cosmopolitics,* it becomes evident that this work too has undergone the same process of manipulation while translated from French to English, to reflect the evolution and refinement of Stengers' thought. The differences, however, are minor and do not justify referring to both versions. The thesis will therefore refer only to the English version. For the claim of non-universality Cf. Prigogine and Stengers, *Order out of Chaos*, 285.

[5] It is necessary to anticipate that this is a different instability than the progressive strengthening of theories through the resistance to invalidation that was proposed by Popper. Cf. Karl Popper, *The Logic of Scientific Discovery* (London: Routledge, 2009).

discussion of the image of truth and value; that is, of effectiveness and relevance. The complex behaviours studied by Prigogine present a challenge that ontology cannot ignore.

Reductionism and Ontology - The relation between philosophy and science is marred by a tendency in philosophical questions to identify science with *physics*, thereby perpetuating the age-old dualism that reduces the presence of matter to pure forms, or object to concept. In this image of science matter is inert, reduced to space-time problems, and givenness is only a material affair. Within this frame emerges the ontological separation of *res cogitans* and *res extensa* that confines aesthetics to the realm of *the perception of that which appears to the senses* (hence the identification of art with a medium-technique, but also the hierarchy of *obscure and confuse* perceptions versus *clear and distinct* intelligibility); a realm ruled by the same laws that rule matter in dynamics, but with the double standard that sees the matter of physics as fundamental and axiomatic, while the matter of the senses is instead superficial, subjective, and contingent. In parallel, philosophy still idealizes; it *reduces* all logics to ontology, as the method and ground for all lines of questioning. Prigogine and Stengers point out how to this image of science there corresponds an image of nature; both are rooted in the reduction of the complex to the simple. This "identification of the real" via reducibility –they go on to explain- is nothing less than the paradigm at the base of the birth of science in the seventeen century, but far from remaining limited to the problems of the early scientific questions, it continues to inform the investigation in the present.[6]   Science is reductionist because it reflects an image of thought, presented primarily as ontology, which is reductionist. As will be seen in this chapter, this reductionist paradigm is so entrenched in thought that it even captures the chaotic behaviours of complex processes by indentifying chaos with a horizon of ontological possibility.

While the image of ontological horizon recalls Heidegger, a relational interpretation of identity only apparently overcomes this impasse. Indeed, if "Being and thinking belong

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[6] Cf. "The Identification of the Real", in Prigogine and Stengers, *Order out of Chaos*, 57–78. This is also the underlying theme of Prigogine and Stengers' second collaboration *Tra il Tempo e L'Eternità*.

together in the same," the reduction to sameness has not been dispelled but only shifted to a new position. In fact, it is not enough to abandon a punctual identity for a relational field, if the relationship between the present and the ultimate is posed as the ultimate in its turn.[7] There too linearity is retained as if in the transition to and from the limit nothing would be lost and nothing would be gained.

In fact, Prigogine and Stengers expose how this reductionism, shared by ontology and integrable dynamics, actively denies temporality making time external and matter inert.[8] Ontology ignores the limitations and the constrictions of temporality, it thinks the relation to the ultimate in ideal terms and in so doing attributes to sense a logic abstracted from its contingent existence. Complexity opens another path.

Image of Science and Image of Thought - The crisis of foundations at the turn of the last century had a limited impact on this continuity. At the same time, ontology survived in the wake of its impossibility. The simulacra that followed could never get rid of the negativity that tainted them, existing as the paradoxical situation of an *aesthetic* without *ontology*. While a definition in negative terms was perhaps inevitable, it is finally time to move past the age of mourning. What is needed is a paradigm change. The association of ontology and physics has consolidated the reductionist paradigm. To paraphrase Stengers, *ontology presents itself as the only discourse endowed with the right to speak on behalf of the logic of existence*. However, if for Stengers this led to expose science as a *practice,* a discourse generating factishes rather than a neutral vehicle of truth, philosophy still needs to admit

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[7] In fact, it would seem that the onto-theological paradigm that Heidegger would like to steer clear of, is not residing in language –as he individuates in "The Onto-Theo-Logical Constitution Of Metaphysics"– but in the very ontological reductionism he too falls victim of by identifying the relation of Being and Thought, or Being and beings, as their proper place (authenticity), thereby evoking the ground all over again. Cf. Martin Heidegger, *Identity and Difference*, trans. Joan Stambaugh, (New York, NY: Harper & Row, 1969), 42-74. While this is not the place for a discussion of the notion of temporality in Heidegger, it is worth pointing out that the Heideggerian ontology is a move that seeks to nest the contingent temporality of the present into a pure form of temporal existence, which once again privileges idealisation and linearity for the construction of the logic of sense.

[8] A system is integrable systems are when any state can be reduced to the initial conditions/axioms without loss of information or energy. Such systems are "static and deterministic" and are at the root of classic mechanics. They imply a spatialised representation whose symmetry entails temporal reversibility. Cf. Prigogine, *The End of Certainty*, 38-41.

that it is itself a *practice*.[9] As much as Prigogine and Stengers are trying to reconceptualise the image of science from inside science, so should philosophy change the image it has of itself (image of thought) by questioning the logic that roots all phenomena in Being as surfaces of substance; that is, by rejecting the hierarchy that raises ontology to the core logic of philosophy.[10]

Philosophy as a discourse of reduction to the simple or to the limit still pivots around *identity*, whether grounded or groundless. This reductionist paradigm is twofold: firstly, philosophy is *ontology*, it discusses essence or the lack thereof. In turn, ontology is presented as the *primary and fundamental discourse* of philosophy, the only voice that can really speak of the logic of existence. In so doing, philosophy applies to itself the very image of thought it has for the logic of existence. The groundless-ground move or one built on difference attempted to break this circularity, at least by exposing it, but failed to escape it and remained caught in the mourning of the crisis of foundations.

In other words, part of the reason that makes philosophy give a pre-eminence to physics as the image of science (and within that, for reducing science to the model of classical dynamics) is the ontological paradigm that philosophy has not yet been able to shake off. However, Prigogine's work, leads to a withdrawal of all claims of "extraterritoriality" presented by physics.[11] It is physics that no longer lends itself to this linear association of fundamental in laws of matter with ontological essentialism. Even before being captured by the onto-theo-logical paradigm, philosophy must take into account

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[9] This problem will be discussed in detail in Chapter 4. The summary of Stengers' analysis is that the experiment implies conferring authority: "*the invention of the power to confer on things the power of conferring on the experimenter the power to speak in their name*;" as will be seen, it is possible to rephrase this as: the *ontologist* has the power, to confer to *language* the power, to entrust the *philosopher* with the right to speak on behalf of the logic of *existence*. Cf. Isabelle Stengers, *The Invention of Modern Science*, trans. Daniel W. Smith (Minneapolis, MN: University of Minnesota Press, 2000), 86; and Isabelle Stengers, "Deleuze and Guattari's Last Enigmatic Message," *Angelaki* 10 no. 2 (2005): 151–167. However for Stengers this three-fold synthesis is what exposes science as a practice (a discourse generating factishes) rather than a neutral vehicle for truth. Philosophy, trapped in the onto-theo-logical, still needs to accept this.

[10] Once again Stengers offers a key: quoting Nancy Cartwright's critique of the logic of science, she distinguishes between the way the physicist presents herself to herself while in the laboratory, and the way she presents to herself and the philosopher a projected image of science. Cf. Stengers, "The Physicists' Double Standard," in *Cosmopolitics*, Vol.2, 71–85.

[11] For the argument on "extra territoriality" Cf. Stengers, *Cosmopolitics*, Vol.1, 4.

the entirely different image of matter and processes encountered by physics, not as a new truth but as another equally valid image of thought, with equal rights to lay truth claims. It is physics in its practice that encounters a plurality of possible models: whereby science no longer appears homogeneous in formulating its questions and addressing its problems.

Perhaps there is one more nuance to this. Often ontology poses its questions taking inspiration from physics and its encounters with matter. However, it remains unquestioned how the *matter of physics* at microscopic level, should constitute the matter of ontology as well. While they may share similar or tangent questions, physics and philosophy are not the same practice. Assuming that the problems of the latter can be assimilated to the questions of the former already expresses a very specific image of thought.

The attention then should shift to the image of thought that is pushing ontology to seek its logic *deep inside the body* of reality; to install a hierarchy between the *outside* and the *inside*, between the *surface* and the *depth*, which would suit better the practice of anatomy than a questioning about sense and its logic. Likewise, the problematic existence of the *neutrino* seems to function as a proof regarding the absolute character of truth, without elaboration of this generalisation.[12] One is allowed to wonder if the various spatialised presentations of ontological structures and problems (grounds, foundations, abyss, surfaces, skins, rhizome) are not all still functioning in the wake of an image of identity, conceived as a pineal point, always deep inside, centre and ground for the subject. Perhaps, the problem lies not so much with which spatial image, but with thinking ontology *spatially* altogether, by giving thought a *distributed* image; by giving Being a geographic-geometric distribution existing in its entirety a priori. Deleuze had suggested passing from a Euclidean geometry (logic of *existence*) to a "geometry of sufficient reason" (or logic of

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[12] The Speculative Realists make great use of this problem in physics to restore the absolute ground of *certainty*. Cf. Quentin Meillassoux, "Ancestrality," in *After Finitude; An Essay on the Necessity of Contingency*, trans. Ray Brassier (London: Continuum, 2009), 1–27; or Graham Harman, *The Quadruple Object* (Winchester: Zero Books, 2010).

sense).[13] *Temporality* is key for tackling this problem, but not in the dualistic structure that opposes it to space, for this would lead it either to a dialectical sublation or to the reciprocity of a relational identity - simultaneous yes, but still spatialised.

2.2 Fragility

Isabelle Stengers opens *Cosmopolitics* with the intent to "rework the notion of coherence" that supports the scientist's claim of truth. The work she had done with Ilya Prigogine in the previous two decades had exposed how science is *not homogeneous* in addressing the questions it encounters; this leaves science in a *fragile* state where claims of universality and certainty have to yield not to subjective relativism, but to the fact that different mathematical models can produce alternative and yet equally valid descriptions of nature.[14] Science is then caught between the "passion for truth" of the scientist, who aspires to universality on the ground of certainty, and the "humour of truth", where the "power of fiction" represented by the sophist contends with the constraints of the materiality of the practice (as both the laboratory processes and their mathematical models, which permit asking questions in the first place) the meaning to be attributed to the *event* of scientific rationality; not leading to the relativity of truth but to the "truth of the relative."[15] In fact, this fragility must be understood as a form of *finitude*, which involves both the image of the world that science projects and investigates and the epistemological paradigm that this image embodies.[16] In both cases, this finitude is by no means a limit, or the sign of a

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[13] For the distinction of these two geometries Cf. Gilles Deleuze, "The Image of Thought," in *Difference and Repetition*, 164–213. For distinction of *existence* versus *sense* Cf. Gilles Deleuze, "Review of Jean Hyppolite, Logique et Existence," in Jean Hyppolite, *Logic and Existence*, trans. Leonard Lawlor and Amit Sen (Albany, NY: State University of New York Press, 1997), 191–196.

[14] Cf. Stengers, "The Science Wars," in *Cosmopolitics*, Vol.1, 1–83.

[15] Cf. Ibid., These concepts have been at the core of Stengers' work in a number of publications. Science as an event was introduced in "Irony and Humour," in *The Invention of Modern Science*, 57–70; this was also the ontological frame for Prigogine and Stengers, *Tra il Tempo e l"Eternità*. The figure of the sophist also appears in the same texts, and returns in *Cosmopolitics*. Stengers develops it further in "Deleuze and Guattari's Last Enigmatic Message," 151–167. Supra: this will be discussed in greater detail in Chapter 4.

[16] The interpretation of the Kantian problematic ideas that is put forward by Deleuze in "The Image of Thought" has a deep influence on Stengers' work. There, ideas are presented not as a priori, but *encountered* as *problems*. This in fact turns the notion of image around: not simply an enframing as per Heidegger's original concept (from which Deleuze draws his notion of image of thought), as something which prevents the authentic relationship with

weakness of the scientist; on the contrary, it is *positive*. Prigogine and Stengers will show how finitude is in fact the condition for the very existence of the physical universe; that is, the condition for the givenness of the object, as much as it is the condition for thought at epistemological and ontological level. Following this, on the one hand, Stengers will develop the onto-epistemological positivity of this finitude with the notion of *factish*: not a matter of fact nor a fetish, or simulacrum, but the aesthetic construction of the conceptual and material dimensions of the practice of science and its object (Stengers sees these dimensions as *constraints*: the *requirements* and *obligations* intrinsic in both the mathematical modelling and the experimental work), ultimately pointing at a reconceptualization of the notion of *materialism*.[17] On the other, Prigogine will concentrate on showing that positive finitude is the condition for the irreversibility of the arrow of time. This will allow him to achieve a reconceptualization of dynamics around the notion of *equilibrium* rather than integrability; this includes temporality at a fundamental level.

This move is twofold: a) Prigogine exposes how the possibility to abstract via approximations to an exact description is an *arbitrary idealization*, generated by the specific syntax of the mathematical model that informs dynamics. In fact, different mathematical models are possible which can present matter as intrinsically finite and *active*, rather than inert and passive as it has been conceived since Newton.[18] Finitude, therefore, has nothing to do with quantity of extension. The claim of an absolute object existing *in itself*, before and beyond becoming *for us*, is barred by the very laws describing its material processes. That

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Being, but as transcendental in the sense that problems are encountered without the necessity of an a priori absolute and yet are potentially relevant. Later in her work Stengers will apply this concept to the notion of scientific model: a model is a "platform for asking questions and refuting objections," rather than a linear description of nature. Cf. respectively Deleuze, *Difference and Repetition*, 164–213; Martin Heidegger, "The Question Concerning Technology," in *The Question Concerning Technology and Other Essays*, ed. and trans. William Lovitt (New York, NY: Harper, 1977), 3–35; lastly, Cf. Isabelle Stengers, "Provocations of Gaia," lecture at Nottingham Contemporary, Nottingham, 17, February 2015.

[17] The notion of *factish* presented by Stengers is a re-elaboration of the difference between facts and fetishes put forward by Latour. Cf. Bruno Latour, "On the Cult of the Factish Gods," in *On the Modern Cult of the Factish Gods* trans. Catherine Porter and Heather MacLean (Durham, NC: Duke University Press, 2010), 1–66. The other main concept Stengers adopts from Latour (after collaborating with Prigogine) is that of "parliament," and the ensuing diplomacy, on which Stengers will construct her answer to the cosmopolitical question. Supra: Chapter 4 will articulate the argument around the factishes, which Stengers develops in the direction of pragmatism's *relevance* or *mattering*.

[18] The notion of "active matter" was first put forward by Prigogine and Stengers in *Order out of Chaos*, 286–290.

is, finitude is not subjective; born in the limited capabilities of the human observer, a limit that the hypothetical *demons* populating the scientific imaginary could always overcome; nor is it the result of an anthropocentric view of the universe, which would exist only in function of the observer. Rather, measurement is intrinsically finite, and material processes cannot be reduced to the perfect knowledge of initial conditions but are instead *constructed* as intrinsically finite, in themselves as well as for us. b) This bars any form of infinite expenditure of information or energy in exchange for perfect knowledge, which alone would allow absolute knowledge and reversibility and shows that *entropy* is not confined to a weak probability but acts as a universal constant.[19]

Prigogine's Claim - Prigogine's work on *dissipative structures* brought to light the contradiction between dynamics and thermodynamics;[20] that is between a world represented by equivalences and ultimately reversible, and one intrinsically irreversible. The epistemological presuppositions implicit in the mathematical formulations at play in this opposition are the subject of the analysis that Prigogine develops in collaboration with Isabelle Stengers, taking the question to the root of the image physics has projected of itself and of nature.

Initially Prigogine sought a way to reconcile temporality, which appears as a fundamental dimension of existence at macroscopic level, with the fundamental laws of physics, which in classical dynamics as well as quantum mechanics have no base for distinguishing the past from the future.

> "From the point of view defended by Ilya Prigogine, dynamics and quantum
> mechanics are both equally unsatisfactory, for one reduces the difference between
> past and future to the imperfection of our understanding, and the other to the act of
> measurement, or the act of awareness. Both condemn any possibility of coherence

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[19] Cf. Prigogine and Stengers, "Irreversibility – The Entropy Barrier," in *Order out of Chaos*, 257–290; and Prigogine and Stengers, "Il Messaggio dell'Entropia" (The Message of Entropy), in *Tra il Tempo e L'Eternità*, 91–118.

[20] For a detailed and technical exposition of dissipative structures and self-organisation Cf. Grégoire Nicolis and Ilya Prigogine, *Exploring Complexity; an Introduction*, (New York, NY: Freeman and Company, 1998). Cf. also Prigogine and Stengers, "The Science of Complexity," in *Order out of Chaos*, 103–209.

with the body of other practices, scientific, technological, or cognitive, all of which assume the non equivalence of past and future, the "arrow of time"."[21]

This coherence, on which Prigogine and Stengers concentrate, is one between physics and the other practices, as well as between the image of matter and the figure of the scientist as the observer that in classic dynamics as much as quantum mechanics remain external; the latter temporal, the first inert and a-temporal. That is, the coherence of the different practices engaged in the description, elaboration and organization of the present. Pushed by this question, Prigogine and Stengers seek a reformulation of the image of matter and its processes that can include irreversibility at all levels. This will induce a paradigmatic shift where determinism will have to yield its absolute control over reality.[22]

What is more, the problem of time is not specific to physics. On the contrary, it also demands a renegotiation of ontology; one alternative to the totality of Being reflected by classical dynamics and to the groundless ground as encountered in quantum mechanics. Prigogine proposes an answer via a reconceptualization of dynamics that makes the arrow of time an integral and fundamental element in the description of nature, as much as in the existence (life) of the observing scientist. Thus, presenting the scientist not as an external observer, but as participating to the same processes that develop in the matter studied by physics.[23] In fact, physics far from offering an "exemplary role" as a "model for all other forms of knowledge," a "quasi-prophetic function," "disclosed its fragility."[24] Physicists "have lost any theoretical argument for claiming any privilege, whether of *extra territoriality* or precedence," a privileged access to truth; "as scientists they belong to a culture to which in

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[21] Cf. Stengers, *Cosmopolitics*, Vol.2, 101.

[22] As already mentioned Stengers will continue elaborating this question independently. Her intention to "rework this notion of coherence" was in fact to drive the cosmopolitical project. Cf. *Cosmopolitics*, Vol.1, 4. Cf. also Isabelle Stengers, "The Cosmopolitical Proposal," in Bruno Latour and Peter Weibel eds. *Making Things Public*, trans. Liz Carey–Libbrecht (Cambridge, MA: MIT Press, 2005), 994–1003.

[23] This essential participation is discussed in the conclusions of *Order out of Chaos*, "description is dialogue, communication, and it is subject to constraints that demonstrate that we are macroscopic beings embedded in the physical world". See in particular the *feedback loop* between observer and matter where the observer faces dynamics, only to find it an unstable system, hence cut through by randomness, a condition which in turn leads to irreversibility, from which –lastly– dissipative structures emerge thus leading back to the organic life of the observing scientist. Cf. Prigogine and Stengers, "Actors and Spectators," in *Order out of Chaos*, 298–301.

[24] Cf. Stengers, *Cosmopolitics*, Vol.1, 3.

turn they contribute."[25] Coherence is not a truth that transcends history, but one that can only be constructed "within history," "from constraints which situate us but which also enable us to create new possibilities."[26]

It must be noted that here Stengers could not be further from making a new truth claim that would reconceptualise physics as a positive objective affirmation. In fact, this fragility is what remains after Stengers becomes uncomfortable with the possibility that claims of a new theory may emerge from the work she did with Ilya Prigogine. Constructing a logic that permits resisting the formulation of a new theory as a positive truth, is the argument that runs through Stengers' *The Invention of Modern Science*.[27] This distance is the moment where the reconceptualization of dynamics emerging from Prigogine's research for Stengers becomes an *epistemological* problem, where physics undergoes a *counter-actualisation*. Less concerned with the internal truth of Prigogine's enlarged theory, Stengers moves on to investigate the problems Prigogine's theory raises for the canonical representation not only of nature, but for the image physics has of itself and therefore for the image of science that philosophy also has. In this shift, a theory passes from being a transparent language for the description of reality (meta-language), to an opaque and genetic player.[28]

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[25] Cf. Ibid., 4; this quote refers to Prigogine and Stengers, *La Nouvelle Alliance*, 299. Cf. also Stengers *Cosmopolitics*, Vol.1, 262n2.

[26] Cf. Ibid., The quote refers to Prigogine and Stengers *Entre le Temps et l'Éternité*, 193–194.

[27] On this distance Cf. Stengers, *Cosmopolitics*, Vol.1, 3–48, and "The Silent Descendant of the Queen of Heaven," in *Cosmopolitics*, Vol.2, 86–101. Regarding the distance between Prigogine's research project and Stengers' new questions Cf. also Matthijs Kouw and Sjoerd Van Tuinen, "Blinded by Science? Speculative Realism and Speculative Constructivism," in Sarah De Sanctis and Anna Longo eds. *Breaking the Spell: Contemporary Realism Under Discussion* (Milano: Mimesis International, 2015), 115–130.

[28] The problem of the *non-objective* representation of nature and of the *apparatus* as an interventionist tool has been addressed by many (see Bohr, Barad for positive analyses, or Agamben for a reactionary mis-interpretation of this problem). The apparatus however, is not Stengers' question; what she seeks is a logic of the *event* of science, where all the players (nature, phenomena, observer) emerge in simultaneity dictating their relevance, while neither exists prior to their relation. In this sense, Stengers' event is trying to overcome also the metaphysical remainders in Heidegger's "event of appropriation," where Being and beings exist in a reciprocally transcendental relation and yet the relation is presented as "authentic" and assumes the flavour of a truth to be discovered. There, authenticity seems more a matter of fact than a mode of thought.

Prigogine's Work - Ilya Prigogine's problem is not new.[29] In fact, it is the same question that has preoccupied philosophy since Parmenides and Heraclitus pitted *being* against *becoming*. The originality of Prigogine's approach is to engage anew with this question from a "mathematical point of view." However, this does not amount to seek a *unitary theory of everything*, or a holistic unification of the universe and the life in it, but an expansion of scientific theories that would avoid the contradictions that exist at the moment. *Compatibility* becomes the main overall requirement of a scientific quest that wants to include an oriented arrow of time as one of the fundamental properties of the universe. In doing so, this points outside existing paradigms. The point, Prigogine insists, is to "ask which information should physics go by, the regular cyclical motion of the planets, or evolution?" Moreover, should this evolution only be conceived as "moving towards an ideal state of equilibrium" where entropy coincides with disorder? If philosophy has accepted the alternative Being-Becoming as a problem, physics seems to have squarely rejected it, seeking laws that describe matter and the universe through static and eternal axioms.[30]

The question goes at the root of the *image* of the universe, as the pre-conception of science's investigations, and as such it involves science as well as philosophy. Prigogine asks: is the universe to be thought *historically* or *geometrically*?[31] This means asking if ontology expresses an image of Being as an extension existing all at once and eternally, an a priori idealization that implies a spatialisation, or if it is evolving matter. The image of a totality conserved and immutable (as background or of fundamental elements) has been the

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[29] What follows is the summary of an interview with Ilya Prigogine in occasion of the 22nd *Solvay Conference* held in Delphi, Greece, November 24–29, 2001. Last modified April 29, 2011, accessed on June 6, 2016, https://www.youtube.com/watch?v=MnD0IlBvgO4.

[30] In the same interview, on this regard Prigogine discusses Bergson, pointing out how his idea "was interesting in his period," that is in relation to the physics of his time which had posed time as irrelevant. In fact, Prigogine goes as far as questioning the accepted assumption that Bergson had "lost" the debate with Einstein. While Bergson misunderstood Relativity, the problem of an arrow of time, which he hoped to retain, has returned to physics since. Cf. Henri Bergson, "Appendix V, Discussion with Einstein" in *Duration and Simultaneity*, ed. Robert Durie, trans. Leon Jacobson and Mark Lewis (Manchester: Clinamen Press, 1999), 154–159. It will become clear later in the chapter how with this claim Prigogine is not championing Bergson's "philosopher's time" against Einstein. His focus is a formulation of physics that contains irreversibility, rather than declaring time an absolute background dimension. Material processes are irreversible, rather than embedded in the flow of a pre-existing time.

[31] Stengers notices on this point that with the conservation of causality at the base of the image of time, one follows Kant's extension of the laws of dynamics to all phenomena, thus severely limiting the image of matter and sense; Cf. *Cosmopolitics*, Vol.2, 105–106 and 425n1.

image that both modern science and the metaphysical quest for a ground shared; a model where a priori principles becomes *coordinates* for the stage of events on which *recognition* can fulfil the paradigm of representation.[32] On the other hand, thinking the universe in terms of time would radically undo this ontological image, provided time is not grasped once again metaphysically (absolute or teleological), and that it does not become caught in a dualistic opposition to space.[33]

2.3 Prigogine and the Model of Physics

Prigogine seeks a reconceptualization of physics that can overcome the incompatibility of thermodynamics' intrinsic irreversibility and dynamics' ideal reducibility to initial conditions. Moving from Poincaré's discovery of non-integrability and resonances he proposes entropy as a cosmological constant. In this light, it is possible to develop a radically different image of time where the present is finite because the surface's conditions and interactions (aesthetics) are irreducible to a priori fundamentals, or to any totalising ontological definition. This reconceptualization of physics implies or better imposes a reconceptualization of ontology. The logic of sense is turned inside out, abandoning all forms of ontological hierarchy between the present and the ultimate, be it the ground or a transcendental limit.

The impact that the theory of complexity has on *thought* can be summarized as the introduction of a *plurality* in the image of matter and its discourse. Complexity undoes the totalising claims regarding the unity of nature as well as the homogeneous image that physics had projected of itself as nature's description, reflecting in classical dynamics the

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[32] "Recognition" is among the main pre-conceptions that silently structure "the image of thought," as coordinates of logic; Cf. Deleuze, "Image of Thought" in *Difference and Repetition*, 164–213. In fact, whether this ground is an axiomatic logical foundation or a geometrical-spatial stage for motion, there remains that all events are conceived as contained a priori by these dimensions; a totalizing image of being/universe inevitably produces a spatialised image/concept of it.

[33] This in fact is a subtle danger that should be avoided at all costs. Prigogine will propose the notion entropy as a new cosmological constant, which in parallel to the speed of light constant introduced by relativity, creates organization by imposing finitude. Time and space follow rather than support a universe thought in this terms. Cf. Prigogine and Stengers, "The entropy Barrier," in *Order out of Chaos*, 295–297; this argument with an emphasis on the importance of demonstrations of impossibility is developed in Prigogine and Stengers, "Il Messaggio dell'Entropia" (The Message of Entropy), in *Tra il Tempo e l'Eternità*, 91–118.

paradigm of modern ontology. In Prigogine's reconceptualisation, physics is found grappling with diverging images of matter, where different conceptualizations can coexist: one built on determinism, logical *integrability* and ideal temporal *reversibility*, the other on *stochastic* processes and temporal *irreversibility*.[34] While this does not entail a dualistic opposition, nevertheless the authority of universality, which since the onset of modern science had been the fundamental requirement of the scientific law, becomes precarious.[35] The law emerges as *local* and *heterogeneous*, requiring site-specific forms of negotiation to assert itself where conditions precede it.[36] At the same time, complexity introduces a different kind of *continuity* across sciences; one which undoes the steep hierarchy that saw physics holding a primary and essential role, as the science of fundamental laws, thereby reducing complex processes, such as biology or the macroscopic study of populations in molecules or human sciences, to near-ephemeral epiphenomena.[37] However, and this is paramount, Prigogine and Stengers emphasise that this continuity is not introducing a new universality;[38] rather it is a movement of *counter-actualization* whereby the notion of the *ultimate* -and of the image of a linearity necessary to put the present in communication with it whether as its ground or its limit- releases its grip and sciences are re-aligned along the same front; dynamics is no longer privileged in the hierarchy of knowledge. Moreover, as it will be shown, this front is not the *edge between order and chaos*, but rather the very horizon of sense. To be clear: linearity is undone; Prigogine demonstrates that the continuity between the present and the ultimate is the product of an idealization.[39] Another continuity emerges, whereby bifurcations and chaotic fugues are encountered across sciences at different degrees of magnitude (from unstable microscopic particles to the

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[34] Cf. Nicolis and Prigogine, "Prologue: Science in an Age of Transition," in *Exploring Complexity*, 1–3.

[35] Kant's critique is the pivotal moment where the notions of law and universality become associated and, for this reason, the target of repeated criticism by Stengers as the thought that sanctioned one form of rationality as truth.

[36] Cf. John Holland, "Closing," in *Emergence, from Chaos to Order* (New York: Basic Books, 1998), 221–248; and Stengers, "The Law of Chaos?," in *Cosmopolitics*, Vol.2, 176–191.

[37] Nicolis and Prigogine, *Exploring Complexity*, 3.

[38] Cf. Prigogine and Stengers, *Order out of Chaos*, 285.

[39] In complex systems, given the same boundary conditions more than one solution becomes possible. This idealization is the fundamental theme of Prigogine and Stengers *Tra il Tempo e l'Eternità*.

macroscopic history of populations), yet this is non-totalisable and non-hierarchical.[40] In fact, Nicolis and Prigogine emphasise that in abandoning the continuity of linearity, the very notion of *system* becomes restrictive and, especially regarding chaos, it is correct and proper to speak of *behaviours* emerging from different conditions.[41]

Prigogine and Stengers' Trajectory - Prigogine's research focuses on the emergence of organization in physico-chemical processes in thermodynamics, where entropy is the price for the emergence of order or *dissipative structures*: temporary forms of organization with an increase in order and information, which last as long as there is a flow of energy through the system. Hence, their stability is not absolute, their identity is not the expression of a concept, but they are continuously emergent and *metastable*. This proposes a non-axiomatic evolutionary model for givenness. Once the theorization of dissipative structures was completed (this research won Prigogine a Nobel prize in 1977), Prigogine began questioning the abyssal discrepancy that separates these macroscopic temporal phenomena from dynamics and quantum theories, which have no tools for a fundamental distinction between before and after.

To solve this incompatibility Prigogine embarks in an investigation, which will lead him to "swim upstream"" -says Stengers- and to question the very fundamental principles of physics.[42] Here his question changes gear: from a scientific research upon a problem, it becomes and *epistemological* question regarding the image of nature and the mathematical models adopted to describe it or -anticipating his conclusions- the mathematical model upon which an image of nature is constructed and an image of science is projected.

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[40] This "less destructive coexistence with nature" that Nicolis and Prigogine seek, directly echoes Heidegger's preoccupation raised concerning technology. Cf. Heidegger, the "Question Concerning Technology," 3–35 and Cf. Nicolis and Prigogine, *Exploring Complexity*, 1. Prigogine reaffirmed this in the interview at the Solvay conference, stating that "the fact that there are bifurcations everywhere does not constitute a unity." Cf. Prigogine Solvay interview https://www.youtube.com/watch?v=MnD0IlBvgO4, last accessed June 6, 2016.

[41] Nicolis and Prigogine, *Exploring Complexity*, 8.

[42] Cf. Stengers, *Cosmopolitics*, Vol.2, 101. It is important to hear Stengers' comments on this development of Prigogine's quest: Prigogine theory, in spite of being rewarded with the Nobel price, has not been embraced by physicists. Physics has continued to operate inside the existing paradigm undisturbed. So, rather than presenting Prigogine's work as a complete conclusion, it is still necessary to explain its details in order to make its reasons heard. Cf. Stengers, "The Arrow of Time," *Cosmopolitics*, Vol.2, 118–122.

Stengers collaborates with Prigogine in the philosophical articulation of this reconceptualization of physics at the beginning of her career. Later, she will renew this question independently and address anew the notion of *coherence* that gives ground to both the scientist and the object of science (the *construction* of the object nature), and at the same time the practice of science together with other practices and processes. Stengers asks this question in such a radical manner that what for Prigogine was a step from science to epistemology, now expands from science and epistemology to reach all the way into the core of *ontology*. The entire logic of sense is now in question. However, as it will be seen, the results will precisely undermine the logic that supports the hierarchy implicit in this notion of *expansion* or progressive abstraction towards a more fundamental level.

Prigogine performs an enlargement of dynamics that includes the kinetic model and takes the properties of ensembles as primary units, rather than the individual descriptions adopted by classical dynamics. His aim was an explanation for the univocal arrow of time, entropy, beyond the illusion to which the accepted model of dynamics had confined it. Yet, something else can also be extracted from his work: Prigogine constructs his demonstration on Poincaré's proof of non-integrability. However, while his interest is to prove the absolute direction of time, by shifting the emphasis on ensembles and onto the macroscopic properties of large systems, Prigogine effectively shifts the ground for the logic of coherence of a system from the initial conditions to the *present*. This alters the traditional image of the present as the superficial expression of a deeper ontological reason, the realm of phenomenology and perception. What is more, a non-integrable present is exposed as intrinsically *finite*; the ontological distinction between *aesthetics* and *ontology*, between the transient or superficial and the ultimate (ground or limit) has become meaningless. Yet, this does not amount to a claim of immanence, which would see the present as self-sufficient. Indeed, the systems encountered in Prigogine's work are *meta-stable* systems; open and cohesive only thanks to a flow of energy that feeds their instability, keeping it at a steady distance from equilibrium.

The solutions adopted by ontology so far have recurred to a transcendental identity to ground the coherence of such systems, or to a sign deprived of ground (simulacrum), thereby remaining within the dualistic paradigm that organises sense as a distribution of concept and object.[43] Ground and groundless ground are in fact expressions of the same *foundational* paradigm, one presenting a positive definition (ground), the other stalling on its impossibility (groundless ontology); they both function upon the *continuity of reducibility*, either satisfied or frustrated, as their logic (this includes *difference* as the ontological ultimate). This is no longer the case in the processes studied by Prigogine. The properties expressed by an ensemble can no longer be disqualified as superficial in favour of axioms or fundamental elements, nor the present is just the *surface* of an ultimate reason; rather it is a network of interrelations that do not re-envoy to anything external or more primary. These are dissipative structures whose coherence is constructed on entropy. Their coherence is meta-stable in the sense that the increase in order and information requires dissipation. Meta-stability must be welcomed as the new acceptation of the notion of transcendental in a non-ontological image of thought.

2.4 Prigogine, Boltzmann and Hamilton

The reconceptualization Prigogine achieves is built on the study of equilibrium and far from equilibrium processes. This is a radical shift from a physics modelled on symmetry, as Hamiltonian dynamics.[44] Prigogine, as Stengers says, becomes the heir of Ludwig Boltzmann.[45] Addressing the dissatisfaction for the incompatibility between dynamics and thermodynamics required Prigogine to shift gear from a problem concerning the object of science, internal to science that is, to question on the one hand the dimensions of the

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[43] For the simulacrum the main references are obviously Deleuze and Derrida, but the entire post–structuralist move is under scrutiny here, as much as Heidegger. Cf. Gilles Deleuze, "The Simulacrum and Ancient Philosophy," in *The Logic of Sense,* ed. Constantin V. Boundas, trans. Mark Lester and Charles Stivale (London: Continuum, 2004), 291–320; and Jacques Derrida, "Plato's Pharmacy," in *The Dissemination*, ed. and trans. Barbara Johnson (London: Athlone Press, 1981), 61–119.

[44] William Rowan Hamilton (1805–1865).

[45] Cf. Stengers, "Book V, In The Name of The Arrow of Time: Prigogine's Challenge," *Cosmopolitics*, Vol.2, 105–204; Ludwig Boltzmann (1844–1906).

paradigm that frames such an object, and on the other also the image that the science that studies it has of nature and therefore of itself. Prigogine and Stengers point at the fundamental importance of mathematics in this formulation of the image of matter and time in physics. They highlight what Stengers will call the "obligations of a concept", whereby different mathematical models lead to different images of nature. In fact, the problem of the arrow of time is *generated "within* physics" by the very conceptualization of the description of dynamics*.* "It is physicists, not human beings in general, that find themselves facing conflicting obligations" of reducibility and irreversibility.[46] A concept that obliges, for Stengers is not a concept of identity but rather a genetic concept -as Deleuze proposes in his critique of the image of thought in *Difference and Repetition* - a concept emerged and encountered, whose validity is not absolute but speculative.[47]

In physics, Stengers writes, "dissipation is both required," since without it "the theoretic scope of theory would be restricted to a handful of special cases," and yet it is included without taking into account "the conflict with the theoretical syntax;" it is thereby also "disqualified" as the consequence of the superficiality of approximations.[48] This problem can be traced back to the impasse encountered by Boltzmann when trying to derive a thermodynamic theory from dynamics and to the reasons of his failure.[49] This is in fact where Prigogine begins his questioning on a new formulation of time and also the

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[46] Cf. Stengers, *Cosmopolitics*, Vol.2, 108–9

[47] Cf. Gilles Deleuze, "The Image of Thought", in *Difference and Repetition*, 164–213. There begins here a dialogue or a progressive convergence of Stengers' epistemological reflection and Deleuze and also Deleuze and Guattari's ontology that will lead to an identification of chaotic processes with difference and the virtual, which is not without problems.

[48] Stengers, *Cosmopolitics*, Vol.2, 111

[49] Cf. Dilip Kondepudi and Ilya Prigogine, *Modern Thermodynamics*, (Chichester: Wiley, 2015), 451–452. "When the atomic notion of matter became evident James Clerk Maxwell, Ludwig Boltzmann and others began to formulate the kinetic theory of gasses;" kinetic theory demonstrated how random molecular motion gives rise to pressure. Seeking a precise relationship between temperature and molecular motion: "once the connection between the temperature and energy of an individual molecule was established, the relation between energy as formulated in thermodynamics and the mechanical energy of a molecule became clear. The thermodynamic energy of a system is the sum of all the energy of molecules." However, "what is the microscopic explanation of entropy?" Boltzmann opened the way for statistical thermodynamics relating thermodynamic quantities to the statistical molecular properties. Statistical thermodynamics relates also quantum mechanics to microscopic thermodynamics. For a given total energy 'U' there are a large number of different ways in which that energy can be distributed among the particles of the system. In general there are a large number of microstates that correspond to a given thermodynamic state. James Clerk Maxwell (1831–1879).

pivotal moment that Stengers analyses with regard to the relevance of mathematics in the description of nature. The emphasis here is therefore double, because the relation between Boltzmann and Prigogine is the stepping-stone for the construction of a new theory and, at the same time, the hinge where providing an explanation of time inside physics becomes an *epistemological* problem. The importance of mathematics and the model chosen for the description of nature become fundamental in structuring the image of reality, because they express the articulation of the image of thought first.

In 1872 Boltzmann attempted to formulate a "statistical definition of entropy" that could legitimate the thermodynamic path toward equilibrium.[50] His hope was to explain entropy (the second law of thermodynamics) by establishing a relation between the macroscopic degradation of energy and the microscopic worlds of mechanics on the base of dynamics. The intuition that led Boltzmann was to apply an evolutionary model to physics, where "the collisions between two particles are represented as a strictly dynamic event," therefore reversible, while "collisions within a population of particles can explain the irreversible approach towards equilibrium".[51] This would have allowed "constructing the representation of a process with increasing entropy".[52]

Boltzmann did not succeed. The limitation of his theory was the introduction of a new non-proved hypothesis, that of "molecular chaos," whereby molecules should be un-correlated before collisions. However, according to Stengers' interpretation, Boltzmann's failure is relevant because he had been *obliged* to introduce a new hypothesis by the very model he had chosen for the construction of a mechanical theory of entropy.[53] That is

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[50] Cf. Ibid., XVI.

[51] Cf. Stengers, *Cosmopolitics*, Vol.1, 247. In *Tra il Tempo e l'Eternità* Prigogine and Stengers describe how the concept at the root of Darwinian evolution offered a new model for thinking matter and its processes, emphasizing precisely this asymmetrical relation between the individual trajectory and the behaviour of the ensemble or population, which cannot be considered simply the sum of its parts. Cf. "Quale Sguardo sul Mondo" (Which View of the World), in *Tra il Tempo e l'Eternità*, 45–67.

[52] Cf. Stengers, *Cosmopolitics*, Vol.1, 246

[53] Cf. Stengers, *Cosmopolitics*, Vol.1, 246–253. Boltzmann introduced the *H*–function "which had the property to decrease to a minimum whenever equilibrium was achieved," this was a "triumph": while "the collisions between two particles is represented as a strictly dynamic event, collisions within a population of particles can explain the irreversible approach towards equilibrium. Unfortunately Boltzmann was "later forced to recognize that he had introduced a [new] hypothesis" (molecular chaos) and that the H–theorem was not a direct derivation from

deriving it from dynamics. This was the so-called "Loschmidt's paradox." In 1876 the objection was raised that it was possible to imagine an instantaneous reversal of velocities that would have moved the system away from equilibrium (negative entropy), contradicting the second law.[54] Stengers notices that this thought experiment was "very hypothetical and perfectly unrealizable," nevertheless the objection exposed a fundamental vulnerability in Boltzmann's theorem and forced him to downgrade his claim regarding a decrease of entropy from an *impossibility* to a more modest *improbability*, due to the finite knowledge of macroscopic approximations. But why this theorem, "apparently purely mechanical in nature, was vulnerable to the objections raised in 1876?" Precisely because it was "purely mechanical." Boltzmann had crashed against the implicit consequences of the formulation of classical dynamics. Indeed, the objection brought by Loschmidt about the possibility of inverting the velocities in Boltzmann's theory brought to the fore what had been implicit in the syntaxes of dynamics from the beginning: "the obligations imposed by the Hamiltonian trajectories," which were conceptualized as *individual* and therefore, at least ideally, intrinsically reversible; that is, the (Hamiltonian) equation representing the system can work equally with velocities pointing in either direction, future or past.[55] The reversal was improbable, certainly not witnessed in experience, but not mathematically impossible and that improbability remained as the attribute of entropy.

The kernel of the problem was that Boltzmann had the intuition to think of entropy in terms of *populations* rather than as the sum of individual particles, but calculated them by

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mechanical description, dynamics. Therefore the decrease predicted by *H* was still a mere approximation "the result of our ignorance." For the introduced "hypothesis of molecular chaos to be valid, particles must not be "correlated" before collisions."

[54] Indeed, the objection of Loschmidt doomed Boltzmann's theory. Loschmidt's paradox, described by Stengers as "very hypothetical and perfectly unrealizable," is the "instantaneous reversal of the velocities of all the particles" in a gas. Inverting the equations would, according to this thought experiment, retrace all individual trajectories. "Reverse" collisions would undo what direct collision had "accomplished." Therefore if the system was evolving towards equilibrium, the reversal would push it away from equilibrium and "the magnitude of *H* would increase rather than decrease." That is, Boltzmann's theorem inadvertently provides the possibility of contradicting the second law – "anti–thermodynamic" change. The reversal implies that each molecule is characterized not only by a specific *velocity* but also by a precise *position* relative to other molecules, which does not satisfy the introduced hypothesis of "molecular chaos," for this was based by Boltzmann only on the distribution of velocities at a given moment and "ignored the relative positions of the particles." Cf. Stengers, *Cosmopolitics*, Vol.1, 247–9.

[55] Cf. Stengers, *Cosmopolitics*, Vol.1, 124.

deriving their theory on the base of mechanics (Hamiltonian), which expresses the intrinsic integrability of individual trajectories, therefore explaining entropy with a representation that is indifferent to time. Hence, he failed.

This shows the fundamental "impossibility of explaining irreversibility on the basis of reversibility."[56] *Irreversibility cannot emerge from reversible processes* (this is emphasised throughout *Order out of Chaos*), therefore a new form of *continuity* between the microscopic and the macroscopic must be found. This is what leads Prigogine to address the problem of non-compatibility between the intrinsic *reversibility* of dynamics and the *irreversibility* of thermodynamics through a radical reconceptualization of physics, which includes both and allows for a unidirectional arrow of time.

In hindsight it is possible to see that what was at stake for Boltzmann was a *choice* between remaining "faithful" to dynamics or opening physics to temporality. "He chose to be faithful" to dynamic theory and therefore its obligations.[57] Prigogine and his team instead chose to respond to the *counterfactual* data coming from the macroscopic level (irreversibility). "Their argument was based on the experimental relevance of the kinetic description." They chose to be faithful to the *practice-experiment* rather than the theory.[58]

Perhaps, in his time Boltzmann had no real possibility other than obeying the integrability of dynamics. However, something of fundamental importance hides under these different choices: something broader than the immediate scientific application of the paradigm that informs classic dynamics as well as quantum mechanics (reducibility). In a later comment regarding d'Espagnat's analysis of Prigogine's work, Stengers points out how, when concerning irreversibility, d'Espagnat "maintains a stable opposition between "quantum and classical mechanics" and the "empirical reality" of "dissipative properties;"

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[56] Cf. Prigogine and Stengers, *Tra il Tempo e l'Eternità*, 26–27.

[57] Cf. Ibid., 30.

[58] Cf. Stengers, *Cosmopolitics*, Vol.2, 126. This echoes Thomas Kuhn idea of the paradigm shift, where the scientific community has to acknowledge that the counter-factual instances demand rethinking the theory. Cf. Thomas Kuhn, *The Structure of Scientific Revolutions* (Chicago, IL: University of Chicago Press, 1996. Cf. also Stengers "The Sciences and Their Interpreters" and "The Force of History" in *The Invention of Modern Science*, 1–20 and 39–53.

specifying that the laws of the former are always valid, "even though they are in practice inapplicable to macroscopic systems". While allowing the juxtaposition of the "customary coarse grained procedures as well as the more sophisticated procedures proposed by Prigogine," d'Espagnat finds "untenable" that Prigogine's theory would show classical dynamics or quantum mechanics "as idealizations," because this claim is derived from the *language* of the other two theories, so it must confirm the 'legitimacy' of its starting point. Therefore it would follow that Prigogine "does not have the right to challenge what his derivation implies is legitimate". Stengers highlights that something fundamental is concealed in this reasoning: "the assumption that macroscopic systems as such [the present] entail no obligations". In fact, Prigogine is not simply attempting to re-conduce irreversibility to a dynamic explanation, rather he is turning the paradigm around to explore the possible obligations of the surface of the present. Complexity is not deriving nor borrowing a legitimization from the theory of the microscopic, respecting the hierarchy that rules physics as a much as ontology. Physics, through d'Espagnat's voice, claims control over other layers of reality and other practices, it *colonizes* them says Stengers, on the base of the paradigm it has established for itself *by itself*.[59] As will be seen, a similar fugue from the landscape designed and controlled by the linear paradigm is the research that Mandelbrot develops of the so called "monster curves," which had been marginalized by mathematics as bordering nonsense; thereby discovering an entirely new geometry.[60]

The concealed problem in this paradigm is the rule of the "=" sign in the dynamic equation. That is, the *symmetry* expressed by the authority of dynamics (as the "Queen of Heaven").[61] In fact, Boltzmann could have brushed off Loschmidt's objection on the very base of classic thermodynamics, asking who would have paid the price of the inversion of

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[59] Cf. Stengers, *Cosmopolitics*, Vol.2, 427–8n6. The source is Bernard d'Espagnat, *Reality and the Physicist: Knowledge, Duration, and the Quantum World* (Cambridge: Cambridge University Press, 1989), 119–135. For the notion of *colonisation* Cf. Isabelle Stengers, "Wandering About Materialism," in Levi Bryant, Graham Harman and Nick Srnicek eds. *The Speculative Turn; Continental Materialism and Realism* (Melbourne: re.press, 2011), 368–380.

[60] Cf. Benoit Mandelbrot, *The Fractal Geometry of Nature* (New York, NY: Freeman, 1983).

[61] Cf. Stengers, *Cosmopolitics*, Vol.1, 249.

velocities, what god or demon would have performed that absolute act, which -as it will be shown by Prigogine- would have required an infinite amount of energy. However, it was impossible to raise this question and refute the objection as long as the image of matter structured by dynamics was in place.

Stengers highlights that this objection brought to light the fundamental property of *symmetry* intrinsic in the Hamiltonian equation of dynamics; in fact, it made it "explicit for the first time."[62] A shift has taken place, which -she writes- "had not been explicitly formulated at the time," one where the opposition of reversibility and irreversibility became related to the symmetry or asymmetry of change over time.[63] In the notion of *conservation* of force, which had informed mechanics since the beginning, the "full equality of cause of and effect" coincided with "absence of loss," it did not imply temporal reversibility but the repeatability of work (the image of "rational mechanics" installed since Galileo falling weights). It was the Loschmidt objection that brought a "new conclusion," to the Hamiltonian. Dynamics became the science of "reversible change" not in the "conservative sense" of degradation of energy, but showing that "such change is indifferent to the distinction between before and after."[64] The essential "equivalence" of time developing towards the future or towards the past.[65] Boltzmann *had* to accept the objection because of the "obligations imposed by Hamiltonian trajectories that Loschmidt made explicit for the first time."[66] There would have been no other option inside the image of dynamics available to him. Correlations due to kinetic collisions were taken as "merely phenomenological," that is an approximation to collisions in a "rigorous dynamic sense."[67] However, this objection and the paradigm it supports are based on the assumption that truth is obtained by pushing the present to the limit, that a special condition has the power to rule over all contingent daily situations. This is why the

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[62] Cf. Stengers, *Cosmopolitics*, Vol.2, 124.

[63] Cf. Stengers, *Cosmopolitics*, Vol.1, 250.

[64] Cf. Ibid., 250.

[65] Cf. Prigogine and Stengers, *Tra il Tempo e l'Eternità*, 27.

[66] Cf. Stengers, *Cosmopolitics*, Vol.2, 124.

[67] Cf. Ibid., 125.

Hamiltonian equation has such a great importance in this argument. Modern science, as it began with Galileo, reaches its culmination with the Hamiltonian formulation of the energy equation; the organization of the entire universe around the "=" sign (see also how this reflects the Hegelian *negation*, separating an otherwise concluded totality.)

The fundamental importance of mathematics in describing nature –as Prigogine said- or better the radical role that description plays in the construction and emergence of nature as the object of science, here becomes evident. But this is not all; the formulation of the equivalence of full cause and effect in physics derives from Leibniz's strong interpretation of the principle of sufficient reason. Prigogine and Stengers indicate that with Leibniz the science of motion had become not only a model for science but a model for knowledge in general.[68] Stengers had explained how with the Hamiltonian equation the conservation of force in motions is the same as the possibility to "infer," as Leibniz writes, from the total effect the totality of the cause. This becomes the possibility to invert cause and effect around the "=" sign, without altering the overall amount of energy;[69] *totality* becomes the image of the universe. However, there are other connections to ontology that show a more nuanced link between ontology, sufficient reason and physics.

The Hamiltonian and its Discontents - It was the image of *totality* implied in the Hamiltonian formulation of dynamics that doomed Boltzmann's attempt to legitimize the arrow of time statistically. Entropy had been articulated shortly before Boltzmann through Clausius' two principles of thermodynamics: 1) the energy of the universe is *constant*; 2) the entropy of the universe *approaches its maximum*.[70] William Rowan Hamilton's published his

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[68] Cf. Prigogine and Stengers, *Tra il Tempo e l'Eternità*, 28.

[69] Leibniz states: "from the knowledge of the effect I can always infer its cause." Cf. Gottfried Wilhelm Leibniz, "What is an Idea," in *Leibniz: Selections*, ed. and trans. Philip P. Wiener (New York, NY: Charles Scribner's Sons, 1951.

[70] This description of thermodynamics by Rudolph Clausius (1822–1888) was formulated in 1865. See Kondepudi and Prigogine, *Modern Thermodynamics*, XVII. It must be added that entropy is "a function of the state of the system that increases monotonically for *isolated systems*." Cf. Prigogine, "Glossary," in *The End of Certainty*, 202; my emphasis. While this was –Prigogine says– the first evolutionary formulation of cosmology," (*Modern thermodynamics*, Ibid.), it was this very formulation that implied a discrepancy between entropy and dynamics, setting the totality of energy, or *identity*, in conflict with its progressive transformations and deterioration towards equilibrium, or *becoming*. If Hegel had found a possible mediation for this conflict in dialectics, Physics seemed to ignore becoming, confining the problem to the approximations necessary to bridge the large numbers of

formalization of dynamics in 1834. This presents an image of matter that has consequences beyond physics, for it implies re-conducing dynamics to the principle of *identity* through a reformulation of the conservation of causality in the principle of sufficient reason as equivalence. It can thus speak of matter with the power and the simplicity of *sameness* that ontology had embodied for centuries.

Stengers highlights how Hamilton's new formalization of dynamics brought about an image of physics as a "perfectly determined and intelligible" science; a science legitimized by its ability to confer to "order and beauty" to its object, where the "simplest most beautiful formulation" converges with the "mathematical truth," thereby introducing the aesthetic of *simplicity* of ontological idealization as one of the main attributes of dynamics. The advantage in this simplicity was not only the great simplification of the equations of motion, but also the formulation of the variables of velocity and position independently of each other, "without the value of any one variable limiting the value of any other." That is, an idealization, or *integrability*, able to unbind "the description from contingencies such as observation and measurement."[71] In front of this new strength the formulations of thermodynamics looked like superficial "mimicry" of the system's transformations.[72]

But this is not all; the new formulation becomes an event where it is the "syntax" of the equation that imposes the truth.[73] The new obligation that emerges from Hamilton's formulation is the concept of *totality* as the fundamental logic of the system. This is structured around the "=" sign as the organizer of the system. This generates a "new construct" –says Stengers- "that both presupposes and embodies the power of the = sign".[74] The concept of conservation of force posed by Galileo for falling bodies culminates in this new description. Yet, an inversion of emphasis takes place here: from the conservation of force passing from cause to effect (sufficient reason), discussed by Newton

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interactions taking place in thermodynamic processes, effectively reducing transformations to superficial and inessential epiphenomena.

[71] Cf. Stengers, *Cosmopolitics*, Vol.1, 150–153.

[72] Cf. Stengers, *Cosmopolitics*, Vol.1, 212.

[73] Cf. Stengers, *Cosmopolitics*, Vol.1, 152.

[74] Cf. Ibid., 153.

and Leibniz, the image of the systems shifts to the totality of energy (recalling identity in ontology). The "=" sign in the Hamiltonian acts as a *fulcrum* for an overall static equilibrium. This signifies that a system can be described by a single definition, or "constraint;" "expressed in these terms, the new variables must retain the same value."[75] Totality implies or expresses an absolute intelligibility. Therefore the "=" sign acquires the power to guarantee that the *system is constantly equal to itself*. "It ensures the identity of the system throughout its representational changes", constituting a *zero-sum* ontology where the totality is stable and static. With this shift, physics is effectively recaptured by the idealizations of ontology. The formulation brought by Hamilton "proclaims both the multiplicity of the points of view and their unity," which describes an overall equilibrium or identity; all canonical representations that preserve the value of *H* are "by definition equivalent to all the others."[76] It is the observer who, by changing point of view in the system, highlights the separation between the spent and unspent energy. For Stengers, this amounts to a new territorialisation, where the "mathematical fiction" triumphs over intuition and the physicist becomes a "kind of Platonist;"[77] formal representation and phenomenological description cease to coincide.[78]

This totalisation acts as a spatialisation of the image of the universe, its visual representation as a picture placed in front of the observer (real scientist or ideal demon)

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[75] Cf. Ibid., 154.

[76] Stengers exlains: "Changes of position and velocity are reciprocally defined". As a consequence, dynamic change -by definition- conserves the Hamiltonian, that is energy; "change over time is itself nothing more than a continuous transformation of the canonical variables, a continuous change in the observer's point of view of a system that would itself remain invariant [...] as if it were the observer who is evolving over time." The physicist is not "addressing a set of interacting objects, evolving in space and time, but a being that is so fictionalized that we can indifferently assign temporal change either to that being or to the way it is represented." Cf. Ibid. 154-5.

[77] Cf. Ibid., 154, 156.

[78] Prigogine and Stengers point out how this image of an immutable and static totality (Being) was already in Giordano Bruno's image of the universe, From here they point to Leibniz's notion of individual closed monads mirroring themselves in the totality of God and from there keeping in equilibrium with the totality of the universe, a concept that in turn 'mirrors' the conservation of cause–effect in the principle of sufficient reason Cf. "Il Problema del tempo" (The Problem of Time) and "Uomini e Dei" (Men and Gods), in *Tra il Tempo e l'Eternità*, 21–33 and 45–67. For the theory *perspectivism* with which Leibniz structures his ontology, Cf. also Georg Wilhelm Leibniz, "Discourse on Metaphysics," §8–9 and "The Monadology," §57–58 in *Discourse on Metaphysics and Other Writings*, ed. Peter Lopston, trans. Robert Latta and George R. Montgomery (Toronto: Broadview, 2012), 57–102 and 115–134. What is more, the "=" sign of the Hamiltonian formulation also recalls the Hegelian negation, which acts as a mediator between the individual and the totality; Cf. Georg Wilhelm Friedrich Hegel, *Science of Logic*, ed. H. D. Lewis, trans. A.V. Miller (Amherst, NY: Prometheus Books, 1988).

with well-defined boundaries. Posing an "=" sign as the fulcrum of the system demands well-defined *boundaries* around it. In fact, totalising *is* spatializing; only the projection of a spatial image allows the simultaneity of the present and the horizon of the system. In other words, with the introduction of the "=" sign, sameness becomes the boundary of the system. Indeed, while it is mobile inside the system, sliding anywhere as an internal partition, the "=" sign constitutes the boundary of the system's identity, it represents its totality. All possible distributions organized by this equivalence are temporal contingent beings; their sum or totality is the substance, self-identical and static Being - Parmenides never left the room.

The third dimension of this new territory becomes evident. Simplicity and sameness lead to *integrability*, the reduction of the system to separate and independent variables. The Hamiltonian -Stengers says- "*consists only of kinetic energy*." A "dynamic system could be represented not only as a set of free points, but as set of points stripped of any mutual interaction, each following "its own path" as if the others did not exist, that is *integrable*, like Leibniz's monads."[79] Conservation as the original property of sufficient reason yields. With the "=" equivalence "has been endowed with such power that any trace of a "cause" has been absorbed to the benefit of the triumph of the invariance as such."[80] It is this invariance that permits thinking not only the equivalence of cause and effect, but also time as essentially equivalent in both directions of past and future.[81] This equivalence can be posed only thanks to the reducibility to elementary parts or axioms of an integrable system. No loss and no gain are allowed in transformations, only sameness. Emerging relations, or more technically correlations, are now excluded by definition. The system is conceived and defined *a priori* of its history. "This -Stengers writes- is the perfect physical mathematical realization of the world of Leibnizian monads, which can simultaneously be said to be *causa*

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[79] Cf. Stengers, *Cosmopolitics*, Vol.1, 155. On this issue of integrability and sufficient reason Cf. also Ilya Prigogine and Isabelle Stengers, "Postface: Dynamics from Leibniz to Lucretius," in Michel Serres, *Hermes: Literature, Science, Philosophy*, eds. and trans. Josué V. Harari and David F. Bell (Baltimore, MD: Johns Hopkins University Press, 1982), 135–158.
[80] Cf. Stengers, *Cosmopolitics*, Vol.1, 155.
[81] Cf. Prigogine and Stengers, *Tra il Tempo e l'Eternità*, 27.

sui and faithful local expression of the universe they compose together" mirroring God.[82]

The possibility of abstracting a system into individual-independent elements or trajectories, and of solving its equations entirely without leaving any remainders implies a powerful *transitive* property that permits passing form the present to the boundary or to the origin with simultaneous immediacy; equivalence expresses in an idealized form the logic of continuity encountered in ontology.[83]

Ontological Reductionism and De-materialization - This reducibility sets dynamics forever apart from the transformations of thermodynamics, which instead cannot be separated from the historical and the contingent. Stengers emphasises how Maxwell had defined the abstract perfection of the Hamiltonian formulation of dynamics as the "Queen of Heaven," whose attributes are "incommunicable;"[84] in other words, a completely closed and self-referred perfection, whose "syntax" creates a "fiction," but also constructs its object within it. Boltzmann could never have overcome this barrier. Phenomena defined in terms of thermodynamics could not be linearly derived from dynamics without a radical distortion. According to Stengers' analysis, Maxwell was aware of this impossibility, and chose to operate inside the paradigm of idealization rather than resisting the power of perfection

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[82] Cf. Stengers, *Cosmopolitics*, Vol.1, 156. There are nuances in Leibniz's thought that may complicate this claim. *Compossibility* as the logic of becoming and emergence of sense does not seem to comply smoothly with the notion of the static *totality* of the physical and ontological universe presented as infinity actualized. Human freedom immersed in contingent chronology is *irreducible* according to Leibniz; Cf. Gottfried Wilhelm Leibniz, "Preliminary Dissertation on the Conformity of Faith with Reason," in *Theodicy: An Essay on the Goodness of God, The Freedom of Man, and the Origin of Evil*, ed. Austin Farrer, trans. E.M. Huggard (Charleston, SC: Bibliobazaar, 2007), 75–125. Prigogine and Stengers recognize this in *Tra il Tempo e l'Eternità*, 42–43. There is scope for thinking that compossibility breaks the Hamiltonian *symmetry*. It seems in fact possible to sever Leibniz's metaphysics from his logic of compossible becoming as much as he separates God's actualized infinity from the finite and chronological world of created monads whose deterministic horizon is "vague."
This will be treated in detail in Chapter 3, where Leibniz shall be raised from the footnotes to the dignity of the text, in the discussion of complexity and the simplicity of description in relation to Gregory Chaitin's notion of informational complexity. In fact, Leibniz understands the problem of complexity perfectly well, simply he addresses it from the opposite angle: a causality relation based on equivalence cannot account for very complex (fort composé) systems because it would have to give a description/explanation as large as the system. Chaitin identifies this inflation of causality with the incompressibility of the information needed to describe the present. This is not acceptable only within a linear logic, linear causality. As will be seen, the solution Prigogine will bring is one of probability calculations. Cf. Gregory Chaitin, *Meta Math! The Quest for Omega* (New York, NY: Vintage Books, 2006).

[83] At this point it is easy to see links in various directions. A "zero sum" economy is an integrable system; so is the Hegelian sublation and the problem Adorno has with objects going into their concepts without remainders. All transcendent or axiomatic logic is integrable, while the transcendental is not.

[84] Stengers is quoting a letter from James Clerk Maxwell to his colleague Peter Tate, 1873. Cf. *Cosmopolitics*, Vol.1, 173.

implied by the idealization of dynamics.[85] Once again, the material sensuality of contingency had to yield to abstraction. Maxwell, like Laplace before him, introduced a demon to bridge the discrepancy between dynamics and thermodynamics. What a finite scientist could not measure, an observer endowed with absolute or metaphysical precision could. However, this bridge is not joining the two banks evenly, in fact it reinstates the hierarchical position of dynamics as the language of truth. Thus Maxwell's demon in fact severs the possibility of finding any continuity between dynamics and thermodynamics. The second law is condemned to be valid only at macroscopic level, but becomes illusory at the microscopic one.[86] Dissipation in thermodynamics and with it contingent presence was to become only the result of human finitude, the superficial and lesser knowledge of aesthetics.

Here the demon, or the physicist, acts as an agent of *ontological reductionism*, whenever *approximation* is necessary in proceeding from fundamental description to observation and back. In other words, reducing the present to the *ultimate*, to the equivalence in equations or to sameness, *requires approximations* that are heavily biased on the side of idealization. This not only marks the "triumph of a physics of laws over a physics of phenomena" as Stengers remarks, but guarantees continuity on the base of the most traditional ontological transcendence by subjecting contingent phenomena to the hierarchy of abstraction. The territorialisation brought about by this process of abstraction is (once again) a *de-materialisation* of both matter and of the image of knowledge. The new image of nature must be "indifferent [...] to the procedures of approximation that confer meaning on experimental properties."[87] In fact, this idealization, is itself a process of approximation that not only is not taken into consideration, but is silenced and censored;

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[85] Cf. Ibid., 174.

[86] Stengers explains that the event of dynamics since Lagrange was the "construction of equations whose syntax affirmed the power of equality between "cause' and 'effect', a power that became the creator of a fiction, the constructor of an object" defined according to the terms of the fiction as "space, force, and movement." Thermodynamics and Hamiltonian dynamics develop from this along diverging and incompatible paths. Maxwell's "demon" expresses the hope or the illusion to overcome this incompatibility; that is to overcome the weakness of finitude that imposes "en mass" calculations as probabilities (or approximation) and to see clearly each and every trajectory, on the ideal level of mathematics. Cf. *Cosmopolitics*, Vol.1, 174.

[87] Cf. Ibid., 175.

approximations are made *transparent*.[88] Dynamics installs a *hierarchy* within physics where the Hamiltonian has the privileged position of the representative of truth, while thermodynamics only has the role of calculations limited to practical purposes - the technology of engineers versus the science of physicists.[89] Stengers goes further and clarifies that unlike Laplace's demon, which was limited to a philosophical problem, Maxwell's version installed the hierarchy inside physics, discriminating among practices that addressed the "*same phenomena*."[90] However, this hierarchy installed inside physics has had obvious effects also outside it, engendering an image of science as an exact knowledge superior to the practice. Or more to the point, it has just reinstated the Cartesian distinction between *clear and distinct* ideas versus *obscure and confused* perceptions.

In the preface to *Order out of Chaos*, Prigogine and Stengers trace a parallel between the platonic heritage of western thought and how this became embodied in classic physics and then again in the new particle physics at the end of the nineteen century. Reducibility is parallel to the possibility of abstracting into ideas; most importantly, the possibility to abstract into ideas *from any point in space or moment in time*, for the present is posed just as an epiphenomenon (illusory or not), which is presented as always reducible to eternal static, simple and independent elements (integrable). In classical physic as much as in classical thought, temporality therefore is associated to illusion. The old problem of Parmenides returns, or better it had never left. Here, with the introduction of demons, as agents of transcendental continuity, this platonic heritage becomes a *colonization* of the transformations of thermodynamic phenomena and as well as historical contingent beings. With the Hamiltonian, the "jurisdiction of dynamics appears to have been extended to all the

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[88] In fact language is made transparent. The double standard of conceiving mathematics as endowed with the unique virtue of expressing truth and at the same time being perfectly inert in regard to it recalls many of Wittgenstein's doubts about the representational quality of language. However, it is important to remember that Stengers' critique here is not a simple application of the linguistic turn to science. Her interpretation of the creativity of the constraints of the practice involves a plurality and a reciprocity much broader than positions that see language as the house of Being for instance. Cf. Martin Heidegger, "Letter on 'Humanism,'" in *Pathmarks*, ed. William McNeil, trans. Frank A. Capuzzi (Cambridge: Cambridge University Press, 1988), 239–276.

[89] Cf. Stengers, *Cosmopolitics*, Vol.1, 175.

[90] Cf. Ibid., 175–6.

phenomena described by thermodynamics."[91] Ontology has installed a similar hierarchy, or more correctly has imposed its logic of idealization over the present and the senses, idealization as a forced translation. In fact, the linear reduction to the ultimate in ontology is itself an approximation. Metaphysical or transcendental, groundless ground or difference, all forms of ontology share this same trait of reduction to the ultimate, which presents the logic of Being as purified of contingent issues and, at the same time, ignores the process of purification. In passing from the present to the horizon of the ultimate, only an approximation that forgoes and forgets all genealogies and all bifurcations can give the illusion of a possible reduction of the chronological beings of the present to the logic of Being (at the horizon, as the ground, in the depth, etc.).

Conservation Becomes Equivalence - Boltzmann had crashed against a particular reinterpretation of *principle of sufficient reason*. The reading Stengers has proposed points out that the failure of Boltzmann's attempt to derive the irreversibility of thermodynamics from dynamics is a passage from the principle of sufficient reason stated as "nothing happens without a reason,"[92] to a reinterpretation of the conservation of causality as equivalence, and therefore to the reversibility of events thanks to this transitive property. Evolving from Galileo's ideal conservation of force to Hamilton's formalization as an equation, *conservation* has become *equivalence*; the absolute equivalence implicit in the conservation of motion of dynamics. The shift is one from a *commensurate* cause for the idea that is found in the mind (as Descartes argues in the proof for the existence of God in the third Meditation) to the mathematical formulation where this commensurate value is balanced on the fulcrum of the "=" sign. This installs a *transitive* property between cause and effect, where the affect can be substituted for the cause. There, the *conservation*, crystallized into the *totality* of energy formulated by Clausius, reflects the *ontological totality* that informed the image of the universe that was demanded by Leibniz's "mirroring"

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[91] Cf. Ibid., 177.

[92] Cf. Leibniz, "The Principle of Sufficient Reason," in *Leibniz, Selections*, 93. Cf. also René Descartes, "Meditation Three: Concerning God, That He Exists," in *Discourse on Method and Meditations on First Philosophy*, trans. Donald A. Cress (Indianapolis, IN: Hackett Publishing Company, 1998), 61–80.

metaphor seen earlier, where the created monads do not communicate among themselves, but all see in God the reflection of the totality and harmony of the universe and act accordingly in equilibrium.

Stengers points out how the conservation of motion that Leibniz defended against Newton, as the expression of the possibility to "infer" the total cause from the totality of the effect, with Hamilton becomes the possibility to invert cause and effect around the "=" sign, without with this altering the overall balance of energy of the universe or the totality of ontology.[93] In other words, the "=" sign, by separating the whole into two portions also defines the totality of such whole, behaving effectively as a defining *boundary*. In this definition, the boundary coincides with Being. The claim of equivalence amounts to an act of definition where the principle of sufficient reason is the other face of the coin of the principle of *identity*. Both imply and demand *continuity* to function. It is easy to see how this is exactly the process of enframing that Heidegger wanted to undo in "The Question Concerning Technology" and also how this equivalence is the base for the practice of recognition that Deleuze indicates as one of the most important preconceptions in the modern "image of thought."[94] The subtle danger here is that if this problem is fairly easy to individuate in the mathematical formalism of dynamics equations, as the onto-theological enframing it remains far more elusive. Particularly so when ontology appears to have broken the closed boundary of totality and abandoned the equivalence of the paradigm of representation as in poststructuralism. The question is how to induce ontology to hesitate as much as science did with Prigogine. All the thesis wants to say on this point is that this *symmetry* exists and rules in ontology independently of becoming embodied in dynamics.

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[93] Cf. Samuel Clarke and Gottfried Wilhelm Leibniz, *The Leibniz-Clarke Correspondence: Together With Extracts from Newton's Principia and Opticks* ed. H.G. Alexander (Manchester: Manchester University Press, 1998).

[94] Cf. respectively Heidegger, "The Question Concerning Technology," in *The Question Concerning Technology and other writings*, 3–35; and Deleuze, "The Image of Thought", in *Difference and Repetition*, 164–213. In fact, this is the very root of the concept of "proximity" which Irigaray finds as the mode of capture of "fallogocentrism." Cf. Luce Irigaray, *The Forgetting of Air in Martin Heidegger*, trans. Mary Beth Mader (Austin, TX: University of Texas Press, 1999).

Both require continuity, which is more than the commensurability of cause and effect. It is a total and absolute transitive property.

Full Cause = Total Effect - However, the commensurability required by the principle of sufficient reason was not exclusive to Leibniz's thought. The totality of cause as equivalent to the totality of the effect, was in fact already a Cartesian principle adopted to show that the cause of the idea has to be commensurable to the idea it generates. Sufficient reason as commensurability appeared already in Descartes' Third Meditation, where it acts as the demonstration that the idea of God could only have been placed in the human mind by God himself; thus providing proof for the existence of God. The idea of God as the idea of the "substance that is infinite, independent, supremely intelligent and supremely powerful" cannot be generated in the mind of the subject for this is finite and cannot produce or conceive the idea of an "infinite substance."[95] It follows that the idea of God must have been caused by something that has the same infinite amount of perfection as God; that is, God himself. Indeed, Descartes explains, "there must be at least as much [reality] in the efficient and total cause as there is in the effect of that same cause." Hence, it follows that "something cannot come into being out of nothing, and also that what is more perfect (that is what contains in itself more reality) cannot come into being from what is less perfect."[96] This is how powerful commensurability is.

This expands the problem of dynamical symmetry to the more general level of ontology. Mechanics and ontology embodied an "image of thought," and an image of causality, already projected as a *totality*, where *conservation* demands *equivalence*. A well defined totality with extremely powerful attributes: 1) a clear boundary; 2) the transitive property as the possibility of sliding an "=" sign through it, dividing it into two portions, always re-composable into the zero-sum of the whole. This totalisation is *visual*. Only an *image* can allow thinking its definite boundary; on its base it is also possible to think and

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[95] Cf. Ibid., Descartes, "Meditation Three: Concerning God, That He Exists," in *Meditations on First Philosophy*, 76.
[96] Cf. Ibid., 73.

pose an *external observer*, which supports determinism in science.[97] It is this image of thought that produces representation as the paradigm and recognition as its main practice. It is on this ground that Deleuze will criticize the "image of thought" and the practice of recognition this implies, *recognizing* the cause in the effect on the ground of the principle of *conservation*, not only of force in motion, but conservation of identity, which is the base of representation.[98]

This is important and not just a historical remark, because without understanding how this symmetry is primarily an ontological problem that belongs to the image of thought, it is not possible to grasp the radical relevance of Prigogine finitude and how far the counter-actualization it induces can reach; also it could not be possible to understand how the continuity of sufficient reason can remain in ontology, once the image of totality is undone. Indeed, the continuity of the transitive property required by commensurability is implied a priori of all ontological constructions; the equivalences of Galileo or the symmetry in the formalism of Hamilton are built on this continuity. Therefore it is the continuity that must be tackled.

Leibniz and Commensurability - With Leibniz the *commensurability* of the principle of sufficient reason began to assume some aspects of *symmetry*; when the Hamiltonian is installed as dynamics' formalization, symmetry becomes all-powerful. That is, not only does it install the equivalence of cause and effect, but it also transforms the "=" sign from one of commensurability required by sufficient reason, to the expression of the fixed totality of identity. In fact, sufficient reason per se is not enough to claim that commensurability amounts to equivalence. Newton's example is quite telling: after the initial divine 'push' the universe needs periodic adjustments. Commensurability remains imprecise, somewhat fuzzy. Leibniz instead applies a strong interpretation of the principle of sufficient reason,

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[97] It must be made clear here that this visual totality refers to Descartes and not to Leibniz. In fact, Descartes was thinking in terms of geometric shapes, while with the introduction of the infinitesimal in calculus Leibniz was able to abstract much further.

[98] Cf. Gilles Deleuze, "The Image of Thought" in *Difference and Repetition*, 164–213.

one, which does not permit imprecision or dissipation. God is perfect, therefore his creation must also be perfect, otherwise God's perfection would be weakened.[99]

A key for this interpretation, and also the link for passing from a strictly dynamic problem to one that involves all of thought, can be found in another fragment written by Leibniz in 1676, titled "What is an Idea?".[100] There, Leibniz debates the nature of ideas and more specifically the relation between ideas in the mind and the outside world. At first, the definition seems rather loose: between the expression and what is expressed there must be "something in common," not necessarily a "similarity" but at least a "certain analogy." This analogy would still leave room for interpretations and variations. In the following paragraph, Leibniz tightens the terms of the relation to a near absolute. Whether the representation of things into ideas happens on a natural basis or arbitrarily, the "similarity" required is a "relationship such as there is between a circle and an ellipse […] for there is a one-to-one correspondence between every point of the ellipse and every point of the circle". This, Leibniz says, must be "determined by a certain law". The law is the strong interpretation of the principle of sufficient reason. Now, symmetric "similarity" is discarded for complete coincidence: "every *complete* effect represents a *complete* cause, for from the knowledge of the effect I can always *infer* its cause" [my emphases], and the "world represents God".

This representation for Leibniz is guaranteed by the fact that God has created both the world and the mind, and endowed the mind with the power to infer from its internal operations the truths which correspond perfectly to those external things." Thus Leibniz seals the analogy as a perfect symmetry. Admittedly, he does not go as far as Hamilton, the inference still offers or even requires some distance, the totality –or actualized infinity- of God cannot be reflected nor represented entirely in the *finite* monads. Therefore, time still plays a role for Leibniz. The monads will get to know their determinist future when this will happen on a chronological timeline. On the finite side of the universe, there remains one

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[99] Such was the metaphor of the clockwork universe held by Leibniz against Newton. Cf. Clarke and Leibniz, *The Correspondence*.

[100] Cf. Leibniz, *Leibniz, Selections*, 281–283.

element of vagueness or fuzziness. For Hamilton, on the other hand, the "=" sign installs a symmetry that is also an absolute simultaneity. The totalization of energy or the universe is also a spatialisation of ontology that poses all that there is and all that is not as co-present, balancing on the fulcrum of the "=" sign. Thus the totality becomes perfectly sealed.

In another fragment from 1686 regarding the principle of sufficient reason, Leibniz distinguishes between the *necessity* of mathematics and geometry, which are satisfied by the principle of identity, and the *contingency* of physics and mechanics where "nothing happens without a reason."[101] This permits to better position the importance Stengers attributes to the power of the "=" sign in the Hamiltonian formulation of dynamics. In fact, this formulation pushes the two principles together; yet the conflation it induces is not even. Under the "=" sign, sufficient reason, that is contingency and history, is assimilated to identity, which act as the logic that can exist per se. It is this that leads to the *dematerialization* of physics if favour of the theory, or to the installation of a hierarchy inside physics geared towards idealization rather than explanation of phenomena, as Stengers suggests. Leibniz wants that "a reason must be given for every truth that is not identical or immediate."[102] The totalization operated by of Hamilton instead makes the contingent respond directly to the identical and the immediate. The "equal" sign acquires a "necessity," which did not belong to physics before and further plunges contingency towards the image of an inert matter.

After Boltzmann and Hamilton - The problem that prevents legitimizing the transformations of thermodynamics is a symmetry that expresses the universe under the sign of *sameness*. Seeking an answer to Boltzmann's question must overcome the problems that multiplicity encounters when reduced to the same. Approximations are subject to a "double standard" where the image of science and the experimental practice diverge. That is, approximations cannot be disregarded as irrelevant because necessary only for finite beings, while being nevertheless adopted to make the theory work in practical

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[101] Cf. Leibniz, "The Principle of Sufficient Reason," in *Leibniz, Selections*, 93–5.
[102] Cf. ibid., 94

situations.[103] Rather the solution is in the opposite direction, what is needed is a *reconceptualization*; it is necessary to turn what is seen as a triumph for physics (the totalization) into something "unsatisfactory". The problem is the symmetry of the very syntaxes of the equations of dynamics. If the arrow of time is to be saved from being reduced to an approximation, its reasons "must be constructed in such a way that symmetric equations themselves supply the justification for breaking the symmetry they assert". Indeed, Boltzmann's failure was not a surprise. The impossibility of deriving the arrow of time from dynamics was the expression of what dynamic theory implied since the beginning. Boltzmann's failure only made it explicit.[104] This was a matter of *choice* between temporal intuition and the physics' tradition. Yet it was a choice Boltzmann could not see in his time, therefore he chose to be "faithful" to dynamics. In fact, this blindness was not a weakness but a *paradigm*. Boltzmann choice, Prigogine and Stengers point out, pivoted on the assumption that dynamics was not "one scientific language among many," on the contrary, "it enjoyed a prestige sufficient to overcome the experiential evidence of time".[105] A language that carried an image of the world constructed as an intelligible totality accessible by a *homogeneous* science.

It is this homogeneity that will become counter-actualized by Prigogine's reconceptualization of dynamics. Prigogine will try to construct a "physical-mathematical representation" built on the notion of distance from *equilibrium*, able to "claim the strange ability to bring into existence a reality endowed with the power to dictate its own (and new) conditions of representation" [...] "capable of maintaining the claim that it transcends all the

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[103] As seen earlier, Stengers refers here to Cartwright's "double standard" where the two "divergent obligations" present themselves between the measurement and the theory: a distance between the physicist "at work" and how she "presents herself to the philosopher or herself to herself." It is approximation that bridges the divide. In physics "dissipation is both required," since without it "the theoretic scope of theory would be restricted to a handful of special cases," and yet it is "included" without taking into account "the conflict with the theoretical syntax" and thereby "disqualified" as irrelevant. While in the second instance "the obligations attached to the ideal representation take precedence," in the first when "at work" "the physicist requires only that the theory be relevant" negotiating the transition from theory to practice as smooth and problem free, only to use "the successful negotiation as an experimental confirmation of the theory." Cf. Stengers, *Cosmopolitics*, Vol.2, 110–111.

[104] Cf. Prigogine and Stengers, *Tra il Tempo e l'Eternità*, 35.

[105] Cf. Ibid., 35.

"realities" with which our practices engage."[106] In fact, the problem is the indifference of physicists to Prigogine's work, or the more direct attacks accusing him of "delusions of grandeur."[107] However, the question must be turned around -and this is why it has direct implications for ontology and the image of thought. It is indeed enough to show that sense can happen, that systems can, and indeed do, make sense outside deterministic models, to expose the excessive self-confidence of the deterministic model and its idealization. Totalisation is indeed "broken"; that is, weak and uncertain, open and non-totalizable, since there exists not one but several instances, or indeed the majority of instances, where the symmetry is broken, and equilibrium does not apply as a concept as much as it is not happening in matter. The "delusion of grandeur" was in fact the totalising models of Hamiltonian dynamics (the Queen of Heaven) and its repetition in quantum mechanics. Prigogine's delicate warning (without claiming a new universality) was, on the other hand, strong enough to keep the totalizing synthesis from closing or sublating.

2.5 Prigogine, Finitude and the Image of Time

Acknowledging the non-integrability of dynamics presented by Prigogine, without following the details of his argument, would hollow Prigogine's reconceptualisation of the radical impact this has on ontology. In fact, overlooking how this irreducibility is *intrinsic* to dynamic processes rather than a condition in which they function, would just lead to a generic claim of incompleteness and to repeat existing interpretations such as the irreconcilability of Heidegger's ontology and its post-structuralist re-interpretation of the groundless via simulacra, including the disembodied version of sufficient reason proposed in deleuzean difference. It is therefore necessary to pay attention to the path of Prigogine's explanation to grasp how this leads to an entirely different logic for sense in the present.

In the light of the problems encountered by Boltzmann, Prigogine sought a terrain where the arrow of time demanded by thermodynamics and the absolute image of matter

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[106] Cf. Stengers, *Cosmopolitics*, Vol.2, 121.
[107] Cf. Ibid., 123.

presented in dynamics could be compatible.[108] This led him to rethink at the root how the laws of dynamics must be interpreted and thereby how they should inform the rest of physics. The idealizations of mechanics are thereby exposed as *illegitimate approximations to the same* of a plurality of otherwise heterogeneous and irreversible processes, effectively turning physics on its head. Moving from statistical mechanics, Prigogine was able to show that rather than explaining entropy and temporality by accepting that probability acts only at a macroscopic level, an interpretation that would leave the option of reversibility open although infinitesimally, it is dynamics that is intrinsically statistical and therefore not deterministic.

The solution was a reorganization of physics obtained by shifting the emphasis onto the importance of far from equilibrium conditions in kinetics, rather than idealizing equilibrium states as the model for all other processes.[109] Prigogine's theory is that all dynamic systems are essentially unstable, but that while equilibrium prevents microscopic interactions from having macroscopic effects, the arrow of time is instead present at all degrees of magnitude and conceptualization.[110] This undoes the image of conservation of sameness that had informed the original formulation of physics on the base of the axiomatic model of dynamics. Moreover, it also breaks the *equivalence* between equilibrium states, where individual descriptions and the statistical description of the ensemble coincide, and far from equilibrium conditions, where instead they diverge radically. The *symmetry* between past and future is thereby also broken: while a system at equilibrium is reducible to fundamental *universal* laws (dynamics is respected), far from equilibrium conditions may engender *chaotic behaviours* that are heterogeneous and site-specific, and therefore non-reducible and chronologically irreversible. In this interpretation, Prigogine concludes, entropy becomes a *cosmological constant*, not unlike the speed of light in relativity theory; it

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[108] It is important to emphasise that this quest for compatibility is not to be grasped as aiming at the unification dynamics and thermodynamics; rather it is meant as continuity, coexistence without contradiction. Cf. Prigogine Solvay interview, https://www.youtube.com/watch?v=MnD0IlBvgO4, last accessed June 6, 2016.

[109] Cf. Prigogine "Beyond Newton Laws," in *The End of Certainty*, 107–128.

[110] Cf. Prigogine "Our Dialogue with Nature," in *The End of Certainty*, 153–162; and "La Nascita del Tempo" (The Birth of Time), in *Tra il Tempo e l'Eternità*, 142–163.

is a necessary condition for the very existence of the universe.[111] Irreversibility implies that all systems, including the universe, must be treated as *open* systems; moreover it constitutes the logic able to explain the emergence of *dissipative structures*.[112]

This *reconceptualization* amounts to a *counter-actualization* of the homogeneous image that physics had projected of both nature and science, with a major impact on ontology. Two paths open here: one is the epistemological line of questioning developed by Isabelle Stengers about the notion of possibility and certainty in science; the other follows Prigogine's argument inside physics. This concentrates on the image of time through a reconstruction of the concept of *chaos* and *chance*, no longer understood as a completely undetermined ontological horizon, but as local and *constrained* by the history of the organizations of matter, whose processes result open but finite. The two paths will rejoin in a radical restructuring of the logic of sense. The concepts of possibility and temporality converge here in a radical redefinition of the logic of *coherence of the present*, where nor Being nor identity can retain their foundational authority; and sufficient reason will have to be rethought past radical difference. The present will emerge as *finite*: a singularity, where differentiating between the aesthetic surface of the present and the ontological ultimate has become meaningless. What is more, to bar any return to metaphysics, this demonstration is performed from inside physics without recurring to a new external truth, which -by providing an Archimedean point- would instead reconfirm the dualist paradigm of ontology on a broader scale.

Prigogine's proof is constructed on a demonstration of *impossibility*. Yet, this is not the traditional reductio ad absurdum, which still implies a totality where all but one option would be excluded by the demonstration in favour of one single instance, which therefore

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[111] Cf. Prigogine and Stengers "Irreversibility – The Entropy Barrier" in *Order out of Chaos*, 257–290.

[112] Prigogine and Stengers give a detailed description of *dissipative structures* in *Order out of Chaos*; while the technical aspects of this concept exceeded the scope of this thesis, suffice here to say that the classical view of irreversible processes is that the increase of entropy leads to disorder and equilibrium. Instead, the concept of dissipative structures reveals that irreversible processes can, in fact, create order thanks to dissipation. Irreversible processes make life possible, while information and dissipation diverge; the cosmological implications of radical irreversibility are discussed in *Tra il Tempo e l'Eternità,* 142–163; and in Prigogine, "Does Time Precede Existence?" in *The End of Certainty*, 163–182, where the claim of an *open* universe is made.

survives as proved.[113] Rather, impossibility derives from the statement that *there exists* at least one instance where the ruling law and paradigm do not apply. This single instance is the non-reversibility of dynamic processes in *far from equilibrium conditions* (instability), while the paradigm undermined is *integrability*.[114] In fact, Prigogine found that conditions far from equilibrium constitute the majority of cases. More precisely, the impossibility Prigogine addresses is the *non-integrability* of dynamic systems, and the truth undermined by it is absolute reducibility; that is, the image of a perfect measurement requiring infinite precision, which had supported science since its beginning, as the idealized condition toward which all contingent instances should be elevated as their model. Physics therefore emerges as an intrinsically *finite* practice, intrinsically unable, that is, to attain the absolute knowledge required for thinking the system as a simultaneous totality or -which is the same- as the expression of fundamental axioms. However, and this is paramount, Prigogine shows that the same irreversibility applies to matter, thereby leaving behind any suspicion of dualism left over from a Kantian heritage.[115]

As far as ontology is concerned, all interpretations of the absolute are shattered. This includes the non-modern or post-structuralist interpretations that functioned in the wake of the loss of the absolute, but still retained the same structure (from Nietzsche's death of God, to Deleuze's difference, via Heidegger's groundless ground).[116] Non-integrability severs the continuity between the present and the ultimate, as well as interrupting the transitive property that guaranteed the conservation of sufficient reason. What has been proved impossible, for both physics and ontology, is not only the option of

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[113] Demonstrations by reductio ad absurdum imply the non-demonstrated assumption of the existence of a totality organized by the principle of identity and by its corollary law of the *excluded middle* (either A or not A), which is not dissimilar from the space defined by the Hamiltonian conservation of sameness/energy seen earlier. This arbitrary assumption returns as an essential step in Meillassoux's demonstration of absolute contingency in *After Finitude*, constituting a major flaw in his argument.

[114] An *integrable* system is a system whose interacting parts can be reduced into non-interacting independent fundamental elements without losing the properties displayed by the system acting as a whole. Cf. Prigogine, "Glossary," in *The End of Certainty*, 204.

[115] Cf. Prigogine and Stengers, "Active Matter," in *Order out of Chaos*, 286–290.

[116] Nietzsche's argument was perhaps less immediately concerned with the structure of ontology than Heidegger and Deleuze did attribute to him. Cf. Gilles Deleuze "Nietzsche," in *Pure Immanence: Essays on A Life*, trans. Anne Boyman (New York, NY" Zone Books, 2005), 53–102; and Martin Heidegger "The Word of Nietzsche: 'God is Dead,'" in *The Question Concerning Technology and Other Essays*, 53–112.

reaching the ultimate, but also of thinking it. In fact, the argument put forward in Prigogine's demonstration is such that the ultimate is not simply left to lay beyond reach, still thinkable as *lack* (from Hegel to Žižek, via Lacan) or as a problematic idea (Kant), rather it has simply become meaningless and therefore entirely unable to provide the ground for the logic of sense, and must therefore be abandoned as a reference. Indeed, it must be emphasized as the last point of this exposition of Prigogine's work, it is not the ability of knowledge of the observer that is limited by finitude, rather it is matter and its processes that are shown as intrinsically finite. This overcomes the limits that had impaired Boltzmann's attempt in proving the irreversibility of entropy and opens the door for practices of thought entirely outside the conceptual frames of representational ontology.

Finitude then becomes a particularly relevant concept when thinking sense in the present. Indeed, with the vanishing of the absolute, the paradigm of *representation* that functions on the base of the logic of reducibility loses all authority (whether this is a transcendent idealisation towards Being, ground, or a transcendental transition to the limit of difference). Indeed at the core of Prigogine's argument there is a shift of emphasis onto the interactions among the elements of a system, rather than the identification of the system with the sum of its parts. This is the point where non-integrability exhibits an intrinsic temporal character. The consequence for the image of the sense in the present, the logic of sense that is, could not be greater: a present emerging from interactions and non-reducible to an ultimate (ground or limit) no longer responds to the principle of identity for its organization. The notion of possibility becomes free from any external reference points: what is possible coincides with what is present; and what was *aesthetic* can no longer be confined to the phenomenological surface representing a concept. Indeed, what is original in Prigogine's explanation is that by realigning a number of existing theories, he exposes the accepted image that science had projected of nature as *false*[117] *and thereby* is able to show that finitude is not subjective (phenomenological).

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[117] Equilibrium physics is a "false image of matter." Cf. Prigogine, *The End of Certainty*, 127.

On the basis of this concept of intrinsic finitude it is also possible to renegotiate the debate and the criticism against the Kantian inheritance of a world only *for us,* directing it beyond solipsistic derives or the dualism of subject and object, which has repeatedly come under criticism from Idealism to the recent Speculative Realism.[118] Indeed, it is not an absolute truth that is reconstituted here, but what Stengers will later call a *constructivist* approach to truth, where it is not the case of a weak thought forced to accept the relativity of truth,[119] but the encounter with the "truth of the relative."[120] However, as it will become progressively clear in the chapter, Stengers will be able to make this claim on the basis of the challenge that the reconceptualization operated by Prigogine brings to *certainty* as the paradigm on which science functions.

Prigogine's aim is to prove that entropy is irreversible. The consequence that can be extracted from the model of dynamics he proposes is an ontological instability very different from Heidegger's groundless ground. It is the image of time that is transformed losing all its accepted definitions; thereby undermining the existing structures for the logic of sense. The *present* in Prigogine's theory is *non-reducible*; not to a cause, not to axioms, nor to fundamental laws. This not only severs the link to the absolute and makes the present intrinsically finite, but exposes the ground or ontological horizon as an illegitimate

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[118] Meillassoux here is the main referent since he directly attempts to rebuild an absolute logic "after finitude," but the problem applies to all thinkers working under the umbrella of Speculative Realism.

[119] The concept of *weak thought* was formulated by Rovatti and Vattimo as a way to negotiate via hermeneutics the crisis of foundations and the groundless ground that shaped the post-modern philosophical debate of the last part of the twentieth century. Cf. Pier Aldo Rovatti and Gianni Vattimo *Il Pensiero Debole* (The Weak Thought), (Milano: Feltrinelli, 2010).

[120] This constructivism is a pivotal and very dense concept, since it brings together both the shift from science to epistemology and ontology on the one hand and, on the other, the speculative approach that Stengers borrows from Deleuze as a prism through which she addresses and rearranges the questions raised by Prigogine's reconceptualization of physics. Counter-actualization is obviously a Deleuzean concept, which permeates all of his texts. Stengers is openly drawing from the work of Deleuze and references this notion, which she sees as key in Deleuze thought, directly: Cf. Stengers, "Transition to the Limit," in *Cosmopolitics*, Vol.2, 284–300 and 442n21 where she indicates the Series of the Event as particularly relevant. Also Cf. Gilles Deleuze, "Twenty-First Series of the Event," in *The Logic of Sense*, ed. Constantin V. Boundas, trans. Mark Lester and Charles Stivale (London: continuum, 2004), 169–175. In fact, counter-actualization will become central to Stengers' interpretation of the history of science and the epistemological problems raised in the theory of complexity. However, this is not without problems because through the interpretation of the *possible* as *virtual* –as Stengers does– the problem of identity leaks into the argument again. Cf. Stengers, *Cosmopolitics*, Vol.2, 10 and 263n10.

idealisation.[121] That is, the notion of possibility and that of identity diverge and the possible emerges as radically finite, nevertheless not trapped by a weak interpretation frustrating the paradigm of determinism.

In Prigogine's reconceptualization, the notion of possibility and the image of time emerge as intimately related. The possible no longer draws from a metaphysical or transcendental reservoir, but is constrained by it own history. The possibilities of the present are constrained by the history of the system. Prigogine brings to the fore a *chrono-logical* distance between the present and the ultimate, that is not negotiable via dialectics or through a passage to the limit (the zero of determination of difference), nor it can be reduced following a determinist model.[122] However, there is no opposition at play here. The concept or the virtual, as repositories of absolute possibility, are not denied and replaced, but more quietly are simply becoming irrelevant. The absolute of an ontological ground, or the limit of pure difference, are meaningless for the logic of sense in the present.[123] This shift in the image of time turns inside out the distinction between the aesthetic and the ontological as distributed in a hierarchy of contingency and necessity. Presence becomes primary, without any possibility of thinking the givenness of the given in any of the ontological interpretations available so far. To understand why demonstrating this from inside physics has such radical repercussions, it is necessary to follow the steps Prigogine takes to prove the irreversibility of entropy.

The Image of Time: Prigogine, Poincaré and Ljapunov - Prigogine's reconceptualization of dynamics pivots on Poincaré's demonstration of non-integrability and the effect of resonances in systems with large numbers of particles, shifting from dynamics

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[121] Cf. Prigogine and Stengers, "Il Messaggio dell'Entropia," (The Message of Entropy) in *Tra il Tempo e l'Eternità*, 91–118.

[122] The thesis adopts the spelling *chrono-logical* rather than chronological to emphasise how the irreversibility at stake here is both logical and temporal, and also to show that not only processes cannot be reversed on either plan, but in fact that non-integrability prohibits the separation of temporal sequences and a priori simultaneity.

[123] This is why Stengers speaks of counter-actualisation rather than presenting this problem as a linear paradigm shift. Supra: the difference of this shift from Thomas Kuhn's paradigm shifts will be elaborated in the first section of Chapter 3.

to statistical mechanics, as the conceptual frame for physics.[124] The paradigms that are opposed in this argument are the *individual* description (single trajectory or wave function) and the *statistical* description of the ensemble. The individual description expresses the idealization that informed classic physics; that is, the possibility -in principle- to calculate the evolution of each independent particle with absolute precision, thereby reducing the system to nothing other than the *sum* of its elements.[125] This possibility, if unreachable by a human finite observer, is nevertheless guaranteed by a divine or demonic gaze or by the perfection of mathematical representation. The statistical description on the other hand, refers to the behaviour of systems with a very large number of particles described by kinetics, whose overall properties differ from the properties of the individual particles and where it is not only impossible but meaningless to calculate individual behaviours independently.[126] These approaches constitute two different platforms for investigating phenomena and produce two different images of matter, one inert and reducible, the other active and evolutionary.

Most importantly, Prigogine was able to show that the probabilistic solution is not due to ignorance (the imprecision or weakness of the observer), it is instead intrinsic to measurement and the behaviour of matter.[127] Science is *bound* by the finitude of measurement. In fact, as Isabelle Stengers points out, "measurement is an intrinsic part of physics and not the decision of a human being."[128] Where the reductionist paradigm had

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[124] The shift to kinetics had been already an intuition for Poincaré; Prigogine developed it passing into statistical mechanics. Cf. Henri Poincaré *The Value of Science*, trans. George B. Halsted (New York: The Science Press, 1907), 110–111. Prigogine updated his articulation of this shift in different works. In this chapter the main reference is *The End of Certainty*. *Kinetics* is the study of systems with large number of particles in terms of interactions among particles rather than just properties of independent elements. Cf. Prigogine "Glossary," in *End of Certainty*, 203.

[125] Explaining this distinction is the focus of *End of Certainty*, and (according to Prigogine's interpretation) is reproduced with the due differences in quantum mechanics. Cf. Prigogine, *The End of Certainty*, 35; the extension to quantum mechanics is developed in "A Unified Formulation of Quantum Theory;" Cf. Ibid., 129–154.

[126] The classic example is the pressure and temperature of a gas described in thermodynamics, which are properties that do not belong or exist at the level of the elementary particles of dynamics, which exemplifies the transformations taking place in states far from equilibrium.

[127] Cf. Prigogine and Stengers, *The End of Certainty*, 24. Entropy presented as the result of ignorance or of the observer's finitude is the reciprocal of the dream of idealization at intelligible level.

[128] Stengers goes on to specify that measurement's "inevitable role in quantum mechanics can from now on be expressed without any appeal to human subjectivity;" Cf. Stengers, *Cosmopolitics*, Vol.2, 158. As mentioned in the introduction, this intrinsic role of measurement is not repeating the problems encountered in quantum mechanics, but is expression of Stengers' approach to the practice of science through a speculative prism, which she derives

confined time to an epiphenomenon emerging from the imprecision of approximation, the intrinsic finitude of measurement constitutes the logic of *non-integrability*, exposing the impossibility of absolute measure intrinsic to any description.[129]

What is at stake is an *image of time* that progressively shifts. The time expressed by the conservation of sufficient reason that informed classic mechanics (collisions) is *linear*. It retains the commensurability of cause and effect from the past, through the present, into the future - as Leibniz maintained. Time acts as an abstract and external coordinate, the fourth dimension of the receptacle that provides the stage for events of mechanics.

Figure 1: Linear Time of Sufficient Reason

With the Hamiltonian reformulation of dynamics, commensurability is elevated to sameness. The present acts as a fulcrum balancing past and future and guarantees the

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from Deleuze notion of genetic concept. Cf. Gilles Deleuze, "The Image of Thought," in *Difference and Repetition*, 164–213; and Stengers, "Book 1, The Science Wars," in *Cosmopolitics*, Vol.1, 1–83. On this notion of indeterminism intrinsic to matter, without being caused by the intervention of a human observer, Prigogine quotes Karl Popper: "it is likely that the world would be just as indeterministic as it is, even if there were no observing subjects to experiment with it;" Cf. Prigogine, *The End of Certainty*, 132.

[129] A system is *integrable* when it can be reduced to independent non-interacting parts. If this is possible, solving the equations of motion is trivial. This concept was the kernel of the seventeen-century debates around atomism and is also the other side of the coin in the conservation of motion/causality in the principle of sufficient reason. However, integrability is a broader concept than the interpretation found in dynamics. Leibniz for instance rejects atomism for an infinitesimal divisibility of matter, and yet retains the notion of elementary independent particles with the monads, which he defines "the veritable atoms of nature," although monads are logical entities (Cf. respectively, Gottfried Wilhelm Leibniz, "Introduction, to *New Essays on Human Understanding*," in *The Monadology and Other Philosophical Writings*, ed. and trans. Robert Latta (London: Geoffrey Cumberledge, 1951), 355–404, for the position on matter; and Leibniz, "Monadology," §3, in *Discourse on Metaphysics*, 115–134, for the monad-atom parallel. Ultimately to retrace the commensurability of causality, as sufficient reason demands, it is necessary to reduce the system to *clear and distinct* independent elements (or axioms) in order to guarantee that nothing is lost or gained in the future collisions or exchanges that these will generate.

It is evident how this image persisted not only to inform Hamilton's formulation of dynamics but also the Logical Positivism's aspirations of achieving an absolute axiomatic language endowed with the power to guarantee certainty a priori, which Gödel denied. In fact, the image of the reduction to intelligible fundamental elements, of which the axioms of geometry are perhaps the best example, or of abstraction into pure elementary forms, is pervasive in western thought, as Heidegger identified with the onto-theological limit that bars the path out of metaphysics.

conservation of first cause as identity. The totalised definition of the system becomes the *perimeter of a space* where every point represents a distribution equivalent to any other. This engenders a spatialised representation of time, which in turn reflects the spatialisation of ontology as a totality. However, this is only attainable within the a priori simultaneity of all its extended contingent instances. Thereby reinforcing a point of view that only a metaphysical or divine observer could afford.

Figure 2: Hamilton's Energy Conservation Time
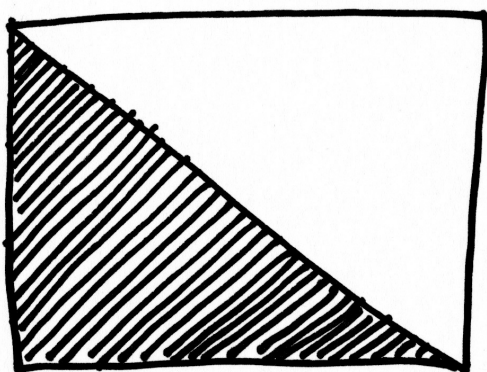
Poincaré - The problem of the finitude of measurement that Prigogine studies had already been framed by Henry Poincaré's analysis of *chance*:

> "If we knew exactly the laws of nature and the situation of the universe at the initial moment, we could predict exactly the situation of that same universe at a succeeding moment. But, even if it were the case that the natural laws had no longer any secret for us, we could still only know the initial situation *approximately*. If that enabled us to predict the succeeding situation *with the same approximation*, that is all we require, and we should say that the phenomenon had been predicted, that it is governed by laws. But it is not always so; it may happen that small differences in the initial conditions produce very great ones in the final phenomena. A small error in the former will produce an enormous error in the latter. Prediction becomes impossible, and we have the fortuitous phenomenon."[130]

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[130] Cf. Henri Poincaré, *Science and Method*, trans. Francis Maitland, (New York: Cosimo Classics, 2007), 68.

The unpredictability of chance revolves around the impossibility of a definition with *absolute* precision. Indeed, for Poincaré individuating a *fact* was far from an obvious exercise. If an infinite amount of time were available to the scientist, it would be enough to "look carefully" and everything would sooner or later become self-evident; but given the time limits of contingent existence, the scientist as much as the historian, and why not the artist, are forced to make a selection among the infinity of facts.[131] The entire edifice of epistemology is summoned to help. The great victim of this inevitable approximation is the continuity postulated by a reductionist logic, which is here *interrupted* (both the *commensurability* that was the guarantee of the continuity of sufficient reason and the simultaneity of totality have to yield). Overcoming this infinite information barrier pushed physicists to postulate demons with the power necessary for such observations. Yet, it is precisely this idealisation that Prigogine exposes in the logic of dynamics as illegitimate.

On the other hand, deciding upon what constitutes a fact or an object is the logic of an artistic practice that operates outside the boundaries of a specific medium, and is also free from the impositions brought in from above by representational intentions. It is the artist who chooses the conceptual frame of the work, who sets where art ends and where the rest of the world begins. Choosing a limit for infinity, or organising what is smooth, is therefore an intrinsically aesthetic act.[132] The question is how to provide a logic for such practice, so that this is not condoned as subjective and superficial opinion in front of the rigorous

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[131] For Poincaré discussion of this problem Cf. "Introduction" and "The Selection of Facts," in *Science and Method*, 9–12 and 15–24. The mathematician Gregory Chaitin encounters the same temporal problem when studying the possibility of defining a priory the boundary of a system evolution, Cf. Gregory Chaitin, "Leibniz Complexity and Incompleteness," streaming video http://www.quizover.com/oer/course/leibniz-complexity-and-incompleteness-by-gregory-chaitin-videolectures, accessed June 6, 2016.

[132] Supra: As will be seen in Chapter 4, this aesthetic act points directly to art. Indeed, approximation will be seen as intrinsically creative. Foucault essay on Magritte's painting *This Is Not a Pipe* analyses this concept in detail. While both authors are working on a problem of visual and linguistic representation, the specific problem they are encountering is one of potential regression to infinity or infinite serialisation (to adopt a Deleuzean term) and it is precisely Magritte's decision to enlarge the subject of painting to encompass the very discourse that had so far contained it. Likewise, at the beginning of this century, with a similar move artists expanded the *material* of art to include the art system and its institutions. Cf. Michel Foucault, "This is not a Pipe," in *The Essential Works of Foucault 1954 – 1984*, Vol. 2 *Aesthetics, Method and Epistemology*, ed. James D. Faubion, trans. James Harkness (London: Penguin, 2000), 187–203.

activities of hard knowledge that engage with the problem of objectivity. The path is to show that such finitude is positive, rather than a limit, the very condition of existence. Let's stay with Poincaré for a while longer.

Figure: 3 Poincaré Recurrence, Cyclical Time
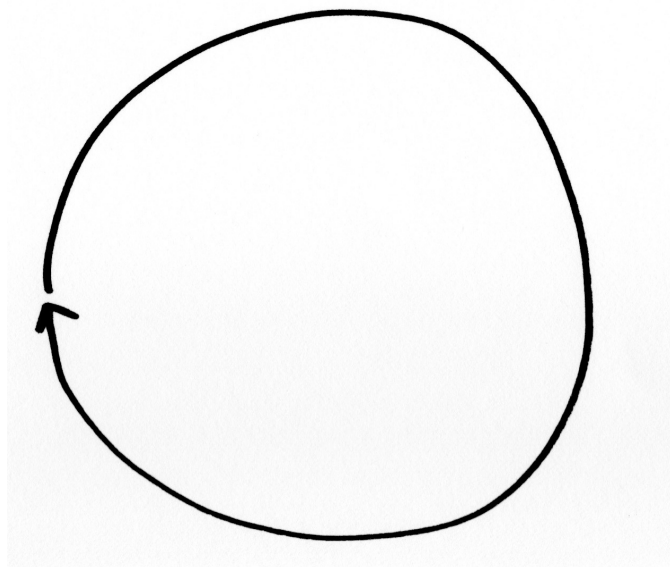
Recurrence - Before reaching these conclusions Poincaré had formulated the theorem of cyclical time, or *recurrence*, which in appearance supported temporal reversibility. A system with a definite number of particles, given a sufficiently long but finite time would return to the same distribution of particles it had in the initial state.[133] This pushed the principle of integrability of classic dynamics to its logical conclusions. Moreover, this recurrence is perfectly deterministic and can, in principle, be extended to the universe as a whole.[134] However, this generalisation immediately encounters a problem: the timescale of a returning cycle even for a simple system would be immensely larger than the life of the existing universe. What is valid in principle, becomes in practice incalculable for

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[133] Cf. John Gribbin, *Deep Simplicity, Chaos, Complexity and the Emergence of Life*, (Penguin: London, 2005), 37–38; and Prigogine, *The End of Certainty*, 9–46.

[134] Regarding this, Prigogine remarks that in such cyclical recurrence the initial conditions lay in a distant past as well as a distant future; the arrow of time would be once again only a phenomenological illusion. Cf. Prigogine and Stengers, *Tra il Tempo e l'Eternità*, 96. What is more, since the initial state is arbitrary, the cycles can repeat to infinity.

large systems. In this light, the arrow of time, or entropy, is just the overwhelmingly probable direction of evolution of the system.[135] While this introduces statistics in mechanics, it is still a *weak* formulation of probability; vulnerable, that is, to a metaphysical idealization: where the scientist cannot calculate, a demon or god could; in principle the system is still integrable and reversible.

Figure: 4 Penrose-Smolin Recurrence[136]

Poincaré Resonances - However, within large systems this *recurrence* is prevented by *resonances*. Poincaré had adopted *phase space* for representing the evolution of systems with very large numbers of particles, thereby reframing the problem in essentially

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[135] Gribbin exemplifies the recurrence with the random shuffling of a deck of cards, which should at some point just happen to return to the same order it had at the start. Furthermore, he explains that since the starting point is arbitrary, the system "must repeatedly go through every possible state." However, what makes the difference between a so called simple system, composed by relatively few elements, and the generalisation of this example is that the recurrence cycle grows exponentially in relation to the number of particles. Cf. Gribbin, *Deep Simplicity*, 37–38. This formulation of probability is the same as the conclusion Boltzmann was forced to accept following the objections moved against his theory.

[136] Recurrence returns in Penrose's definition of time. At high energies near the Big Bang, distant particles are connected by direct relations–dimensions, effectively communicating simultaneously everywhere in the universe. In the cooling off process, dimensions requiring great amounts of energy progressively "shut down," creating geometrical space where the only direct connections are those with adjacent bodies; particles and information are now required to cross each node of the grid and chronological time is born. The emergence of space corresponds to a decay of energy, or entropy. Potential new increases of energy within the hypothesis of a pulsating or ebullient universe would re–open all dimensions and reproduce simultaneous communication. However, in a successive cooling off period, particles would not necessarily decay into the same dimensions experienced in the present universe, thereby producing an open form of recurrence hinging on quantum indeterminacy. Although this is not a perfect cycle, it nevertheless points to an image of ontological ultimate, a state that reflects ontological difference. Cf. Lee Smolin, "The Emergence of Space," in *Time Reborn, From the Crisis of Physics to the Future of the Universe*, (New York–London: Allen Lane, 2013), 172–192. Cf. also Roger Penrose, "The Second Law of Thermodynamics and its Underlying Mystery" and "Conformal Cyclical Cosmology," in *Cycles of Time, An Extraordinary New View of the Universe*, (London: Random House, 2011), 9–55, and 137–219.

geometrical terms.[137] The trajectory representing the evolution of the system in time, according to the recurrence theorem, should cyclically pass through the same *point* in phase space. This would imply that the systems had returned exactly to the initial state and, following the laws of mechanics, should henceforth proceed through the same evolution it followed earlier. However, Poincaré found that this is not always the case, even for simple systems.[138] If the trajectory varies its path through phase space even by the smallest degree, the future evolution will follow a radically different behaviour. Thus, rather than cyclical recurrence, periods typically *diverge exponentially*, breaking all commensurability between cause and effect; that is, the variations in the evolution of the system could be infinite, even if the variation of the trajectory passes infinitesimally close to the initial state.[139] Instability is normal and stability is the exception, and the present cannot be reduced to the description of the past.

This sensitivity to initial conditions is the main characteristic of chaotic behaviours and the kernel of the argument against integrability put forward by Prigogine. Poincaré's formulation of non-integrability goes beyond the contingent finitude of human measurement facing the idealisation of infinite precision, showing that the problem is instead intrinsic to the mathematical representation. In phase space, as along a line, points whose definition is *finite,* that is described by a rational number, with a finite or periodic number of decimals that can be compressed in a shorter description, permit calculating their evolution.

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[137] The representation in phase space reduces the values of the three coordinates necessary to define the position of a body in Euclidean three–dimensional space, to three numbers that measure the distance from a chosen zero point along three axes. The same can be done for the three other values to represent its momentum. A dynamical *state* is thus representable as a *point* on the graph, while its evolution is represented by a line or *trajectory*. It is also possible to represent an entire system composed of large number of particles in the same space, where the *state* of the system is a single *point* and its *evolution* a *trajectory*. The step that makes this a powerful tool for statistical calculation is that it permits combining the value of positions and that of momenta into a single value representing the state and the evolution of very large systems as a single point/trajectory in the space. Moreover, for very large systems, phase space can represent all the possible variables, or *degrees of freedom*, acting in the system; it can represent multiple dimensions that are no longer visualisable individually, other than with the value of the ensemble. Cf. Gribbin, *Deep Simplicity*, 42–45; and Prigogine, *The End of Certainty*, 31–34. For Poincaré's intuition regarding the shift from determinism to statistics Cf. Poincaré, *The Value of Science*, 110–111.

[138] Poincaré applied phase space representation to the *three bodies problem* that had remain open in the calculation of orbits since Newton. Cf. Henri Poincaré, *New Methods of Celestial Mechanics*, ed. David Goroff (College Park, MD: American Institute of Physics, 1997).

[139] Cf. Gribbin, *Deep Simplicity*, 47–50.

However, these are always surrounded by points whose description is infinite, the numbers defining them have an infinite series of decimals, whose sequence is *non-periodic* and therefore *non-compressible* (irrational). The precision required to describe each single point represented by an irrational number would be infinite, and the demon, or the computer, would need an infinite amount of time and energy to perform every single calculation. What is more, the number of such irrational points in phase space overwhelms the rational ones. The description and the calculation of the evolution of such points therefore require *approximation*. Finite measurement implies that in phase space representation description will be not a *point* but a *small region*.[140] Anything that happens beyond this threshold of precision remains intrinsically un-measurable and open to chance, and may lead to radically different evolutions of the system.

In this light, the definition of a *fact* that Poincaré had individuated as a limit to measurement assumes much deeper epistemological implications. In the absence of an absolute definition that can contain the entire system a priori, the choice of a unit of measure may lead to radically different images of matter and the universe. In fact, this choice transcends the domain of epistemology to include politics and ethics, or indeed aesthetics, with the questions of *relevance* and *mattering* that Isabelle Stengers raised when she invoked "thinking in the presence of the victims."[141] A finite degree of precision that carves a measurement out of the smoothness of infinity amounts to a degree of roughness, which constitutes the configuration or dimensions of the object in the present; in fact, it shapes presence and as such it is aesthetic.

The focus of Prigogine reconceptualization of dynamics was to expose how classic mechanics had idealised the exception of rational numbers and modelled physics on this representation of nature. Instead, in his model the equivalence of initial conditions and

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[140] Cf. Prigogine and Stengers, *Tra il Tempo e l'Eternità*, 75.

[141] As will be seen in Chapter 4, Stengers puts great emphasis on presenting the possibility of measurement as an *event*. Cf. respectively: Isabelle Stengers "A Cosmopolitical Proposal," in Latour and Weibel, *Making Things Public*, 994–1003; and "Wandering About Materialism," in Bryant, Harman and Srnicek, *The Specualitve Turn*, 368–380; and Stengers, "Science Under the Sign of the Event" and "Becomings," in *The Invention of Modern Science*, 71–88 and 151–168.

future evolution, that was associated to the symmetry of past and future, is exposed as an exception, maintained only for rational points where calculations are possible because the measurement required is finite.

This is not all. Resonances provide a reason for the impossibility to integrate dynamics, rather than just passively accepting the practical limits of measurement. Dynamic systems are composed of kinetic energy of the *particles* and of the potential energy generated by the particles' *interactions*.[142] At equilibrium there are no interactions between particles and therefore no potential energy; the system can be defined by the sum of the elementary elements that compose it calculated independently. In this case, for a stable system, in the representation in phase space every point is equivalent to any other. The system is isotropic; the *same definition* is valid throughout it and in any moment of its cycle.[143] On the other hand, in far from equilibrium conditions to each mode of motion there belongs a *frequency*. In unstable systems, frequencies with "simple numerical ratio" can *couple* and the "amplitude of the motion […] increases dramatically."[144] That is, and this is key for Poincaré as much as it is for Prigogine, *resonances happen among interactions*. They cannot be derived from the properties of the independent particles at equilibrium; they are therefore intrinsically *relational*. Resonances generate an increase of information above the definition of the initial conditions.[145] This leads to the *diverging* evolutions in phase space, which deviate from the cyclical recurrence of a closed system (through his work on resonances and the three bodies problem Poincaré was able to show that this is a general problem of dynamics.)

Prigogine can thereby explain how breaking the *equivalence* in the spatial description of the system on the base of the distance from equilibrium, breaks the *symmetry*

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[142] Cf. Prigogine, *The End of Certainty*, 39–41.

[143] Cf. Ibid., 108–9 and 38–41. This reflects the image that was expressed by the Hamiltonian representation of dynamics.

[144] Cf. Ibid., 39–41. In technical terms: "coupling of degrees of freedom that lead to divergent expressions due to small denominators if there is a resonance between them; the resonances may prohibit the solution of the equations of motion;" Cf. also "Glossary," in Ibid., 204.

[145] Supra: There are obvious points of contact between the notion of non-integrability described by Poincaré and Gödel's *incompleteness*, which will be addressed later in the chapter.

of the temporal evolution. In a stable system, any point in phase space is equivalent to any other, for they all represent the same overall a priori definition; and the system is integrable, since probability is the same throughout. Vice versa, in an unstable system perturbed by fluctuations points have different definitions, therefore evolutions will diverge and the system is non-integrable. With fluctuations, resonances taking place on points described by irrational numbers will have unpredictable and staggering consequences, after which the probability of finding a point becomes progressively diffused throughout phase space, approaching uniformity in the future. Thereby matching thermodynamic equilibrium and confirming entropy (the arrow of time) by breaking the equivalence between the behaviour evolving from stable or unstable conditions. What makes the difference is the degree of *stability* of the system, rather than the precision of measurement per se.

Resonances introduce uncertainty in dynamics.[146] Thereby posing a limit to integrability that cannot be overcome by idealisation as finite measurement does. This has far reaching consequences, both inside dynamics, and for the conceptual structure of causality and the image of time this supports. To grasp the full ontological import of Prigogine's argument it is important to understand how *chaotic behaviour* is conceptualised within resonances. The image of time here will shift again; giving the *present* a relevance it never had in any of the existing ontological interpretations. The hierarchy that traditionally poses the present in function of the past and/or the future is upturned. The present is no longer confined to the surface, as the aesthetic ephemeral representation of Being; rather it emerges as a network, whose reasons are heterogeneous and local and yet it is not immanent.

Integrability is the explicit description of the law that yields the "variation over the course of time of each of the independent variables" in a system;[147] the possibility of reducing a system to individual non-interacting elements and of solving its equations

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[146] Cf. Prigogine, *The End of Certainty*, 44.
[147] Cf. Stengers, *Cosmopolitics*, Vol.1, 156.

entirely without leaving any remainders.[148] In fact, integrability has deeper roots; it reflects the conservation of sufficient reason as the equivalence of cause and effect defended by Leibniz as well as the reciprocal principle of simplicity he put forward.[149] A *zero sum* economy as the Hegelian sublation is an integrable system, since the entire history is reducible to the same teleology. Integrability is also reflected in a transcendent ontology. Transcendental solutions also function within the paradigm of the *same* (identity), however they have to accept a negative formulation: integration is procrastinated to infinity; that is, the continuity required for passing from the present state to the initial conditions (or ground) is retained as the logic of thought, even if this return of the system to the same point is forever frustrated. In this light, closing the system in a cyclical return produces more than a visual analogy for ontology; it implies a totalisation through the confirmation that *all* has been defined in the systems' description and nothing remains unaccounted. Spatialisation in intrinsic to this image of being and sense.

In resonances instead, the degrees of freedom of the system may couple and multiply the potential energy, thereby diverging exponentially from the description at equilibrium and breaking the cycle. Such coupling produces an asymmetry between causes and effects. Sensitivity to initial conditions may engender an exponential acceleration or fugue, where matter acquires new properties that it did not have and which could not be predicted in the previous conditions (i.e.: *phase transition* from liquid to gas).[150] From a purely dynamic angle, resonances multiply the one-to-one deterministic chain, overtaking and voiding even the idealisation of perfect measurement and the purely hypothetical

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[148] The echo of Adorno's warning that "objects do not go into their concepts without leaving a remainder" is strong. In fact, there is an immediate parallel between the Hamiltonian formulation of dynamics and the Hegelian preservation of sameness through the movement of history. Cf. Theodor Adorno, "Dialectics is not a Standpoint," in *Negative Dialectics*, trans. E. B. Ashton (London: Routledge, 2004), 4–6.

[149] Cf. Prigogine and Stengers "Dynamics from Leibniz to Lucretius" in Serres, *Hermes*, 135–158; and Stengers, "The Stars, like Blessed Gods," in *Cosmopolitics*, Vol.1 150–161. See also Leibniz concerning the simplest curve that can economically describe a set of random points and the simplest reason that can be provided to explain the complexity of the present/system. Cf. Leibniz, "Discourse on Metaphysics," §6, in *Discourse on Metaphysics*, 63–64.

[150] This is the logic of the processes of *emergence* that Prigogine and Stengers described in "The Science of Complexity," in *Order out of Chaos*, 103–209. For the metaphor of the *fugue* in resonances and feedback loops Cf. Douglas Hofstadter, *Gödel, Escher, Back: an Eternal Golden Braid* (New York, NY: Basic Books, 1999).

prediction that this could achieve; while from the point of view of thermodynamics, this coupling produces an increase in the complexity of the system, which requires more information and thereby dissipates more energy. What appears as *uncertainty* for dynamics, becomes *augmented causality* in the statistical approach.[151]

The pattern of such accelerations is one of fractal bifurcations.[152] In conditions of instability, the fluctuations that naturally happen in a system may lead to bifurcations that multiply exponentially the possible paths of the system's evolution.[153] The choice between possible bifurcating branches is *random*. No amount of knowledge could help predict or retrace the direction the system will take.[154] A demon, or an absolute external observer, would be as powerless as the scientist confined in the contingency of their calculation. The *chance* Poincaré had individuated beyond the limit of measurement returns as a fundamental factor in the system's evolution. This, Prigogine points out, undermines certainty by introducing an "irreducible probabilistic element" in the linearity of determinism.[155] In fact, bifurcations break the symmetry between the present and the initial conditions; the possibility of reducing the *now* to the *identity* of the concept or to the *limit* of difference is interrupted. The evolution of a system, or the history of beings, is articulated by *singularities*; hinges where the choice of direction is aleatory, and therefore the mechanical reversal of events is impossible.

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[151] Cf. Prigogine and Stengers, *Tra Tempo e Eternità*, 59. The thesis will return on this impact resonances may have on the economy of causality in Chapter 4, discussing the interpretation that Karen Barad proposes of the phenomena of *diffraction* and *interference* as an image of thought alternative to ontological reductionism. Cf. Karen Barad, *Meeting the Universe Halfway: Quantum Physics and The Entanglement of Matter and Meaning* (Durham, NC: Duke University Press, 2007).

[152] For a description of the bifurcations processes Cf. Prigogine, *The End of Certainty*, 66–72; and Prigogine and Stengers, *Tra il Tempo e l'Eternità*, 61–64. Beyond bifurcation there appear "long-range correlations" at the price of an increase in entropy and new "spatio-temporal organizations" may arise. Prigogine and Stengers have named such new phenomena "dissipative structures." For a detailed description of this processes Cf. Prigogine and Stengers, "The Science of Complexity," in *Order Out of Chaos*, 103–209.

[153] This fractal multiplication is proportional to the energy that acts on the system perturbing its stability. For this and the following paragraph regarding bifurcations in chaotic behaviours Cf. Prigogine, *The End of Certainty*, 64–72; and Prigogine and Stengers, *Tra il Tempo e l'Eternità*, 61–64. Particularly relevant are Feigenbaum's bifurcations, Cf. Gribbin "Chaos out of Order," in *Deep Simplicity*, 70–103, and James Gleick "Universality," in *Chaos; Making a New Science* (London: Vintage, 1988), 155–187.

[154] Cf. Prigogine, *The End of Certainty*, 68.

[155] Cf. Prigogine and Stengers, *Tra il Tempo e l'Eternità*, 61; and Prigogine, *The End of Certainty*, 68.

This begins to delineate how the impossibility at play in this argument is not an external barrier, a limit imposed by a greater order *beyond* the order of contingent history as ontological coordinates; rather it is a dimension intrinsic to the very processes of matter that emerges from its behaviour and pattern. All that Prigogine wants to achieve with this is a demonstration for temporal irreversibility; at the core of this argument however there is an intrinsic finitude concerning the coherence of the present, whose logic cannot be sought beyond its surface.

Correlation Bubbles - There is another aspect to the fractal behaviour of these fugues.[156] Prigogine's reconceptualises dynamics as a *flux of correlations*: even in simple dynamic systems the interactions among particles (collisions) produce and destroy correlations.[157] Over time these events lead to a diffusion of the information generated by the interactions and dynamics appears as a "*history of correlations,*" where the process is as important as the initial conditions for the definition of the present state. Integrating such systems would lose the information built during the process and destroy the surface's properties that have emerged during their history.

Poincaré's resonances intervene on this flux by *coupling* segments of its processes of creation and destruction.[158] That is, new dynamic processes may "start from a given state of correlations" and "eventually return to the same state". These local returning cycles constitute *bubbles* of stability, where returning correlations may act as *platforms* for new processes. Initial conditions lose their privileged status; the correlations' vacuum, that is the mere existence of non-interacting elementary parts, is just one special case among many

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[156] The bubble image is adopted by Prigogine as a rhetorical device to describe the phenomenon of recurrence of sets of correlations in systems with large numbers of particles. It must not be interpreted as an ontological metaphor as it is presented by Sloterdijk in *Bubbles*, part of his trilogy on spheres, divided in bubbles, globes and foam. Cf. Peter Sloterdijk, *Bubbles, Spheres 1,* trans. Wieland Hoban, (Cambridge, MA: The MIT Press, 2011).

[157] Cf. Prigogine, *The End of Certainty*, 78–80 and 120–128. Prigogine insists that this should be understood in the broadest sense possible; that is, not only mechanical collisions produce correlations, but all forms of interactions including exchanges among individuals in society where expansion of relations corresponds to an diffusion of information.

[158] Cf. Ibid., 120–128.

possible distributions and should not be idealised as the necessary starting condition of all dynamical processes.

Moreover, such "bubbles correspond to events that must be considered *as a whole.*" As seen above, resonances may induce accelerations, which lead to the emergence of new properties for matter. These can be only temporarily stable, *metastable* that is, depending on the continuity of the energy they receive. The notion of bubbles provides a dynamical description for the emergence of *dissipative structures* in chemistry, to which Prigogine and Stengers dedicated their first collaboration *Order out of Chaos*.[159]

In the integrable model of classic dynamics based on individual descriptions there is no analogue to such recurring processes. Bubbles are *non-Newtonian* elements active in dynamics. For what concerns the coherence of the present and the image of time associated with causality, this opens a path towards an entirely different logic. Resonances generate events that exist during the coupling of their creation and destruction segments. Between creation and destruction such events may act as platforms for yet more events. However, once they dissolve, the next event, or *effect*, is left without direct cause, which would be needed to allow deterministic reversibility. Poincaré's resonances therefore create new temporary grounds at each loop; the system builds itself upon these ephemeral states. Even if the initial conditions corresponded to a vacuum of correlations, resonances would nevertheless lead to diffusion and the system would forget the initial conditions. What is important, Prigogine points out, is that while at equilibrium laws are *universal*, far from equilibrium matter develops "long range correlations" and laws become "mechanism dependent;" that is laws are *local* and *heterogeneous*.[160]

Ljapunov's Temporal Horizon – The key to the image of time that begins to emerge here is the *temporal horizon* described by the exponent introduced by Aleksandr Ljapunov.[161] Following Poincaré, the impossibility of absolute measurement implies yet

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[159] Cf. Prigogine and Stengers "Order Through Fluctuations," in *Order out of Chaos*, 177–209.
[160] Cf. Prigogine, *The End of Certainty*, 64–65.
[161] Cf. Prigogine and Stengers, *Tra il Tempo e l'Eternità*, 75. Aleksandr Ljapunov (1857–1918).

another problem: in that phase space, representation will always be a *small region* rather than a *point*. The size of this region can be narrowed down by extending the sequence of decimals of the number that describes it, but it will never reach the absolute precision of a point. Even in simple dynamic systems, the inevitable limit encountered by measurement implies a horizon of precision beyond which unpredictability sets in; or, as Poincaré named it, *chance*. This horizon is a *temporal horizon*. A region of phase space is defined by a degree of roughness in the description of a fact; within it events may vary further than the threshold afforded by the finite description. Therefore, over time, the state contained in one region-description (the present) may evolve into different possible futures. Evolutions will diverge exponentially in inverse proportion to the degree of precision of the definition of their initial conditions.[162]

The degree of divergence among evolutions, or Ljapunov's exponent, constitutes a *window* of predictability within which all points in the region selected by the original definition will maintain an evolution commensurable with the initial description (sameness is preserved). However, after a finite amount of time, the initial conditions will lose any relevance for the prediction of future evolutions and the system will behave *chaotically.* This temporal horizon can be expanded by increasing precision, but can never be eliminated, since this would require infinite information/energy and would run against the barrier set by entropy.

Even for the most classical representation of time as a line stretching from past to future, Ljapunov's horizon interrupts absolute predictability and constitutes a segment on the arrow of time, an *area* defined by the roughness of description; a finite island of sense and order in the flow of collisions and correlations, whose boundary becomes progressively out of focus, and where the notion of representation (integrability) is increasingly difficult to uphold. Obviously, shifting the Ljapunov temporal frame forward will not produce any clearer information about the ultimate, since it is in all effects a receding horizon.

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[162] Cf. Ibid., 74–75.

This is one of the pivots of Prigogine's demonstration: in the future beyond the horizon determined by the Ljapunov exponent, what began as a deterministic process in a simple dynamical system leads nevertheless to randomness (chaos) and the system is not integrable.[163] Likewise, for the same reason, this horizon bars retracing the evolution of a process in the past. What is more, Ljapunov's time is necessarily shorter than Poincaré's recurrence, thereby reinforcing the non-cyclical movement of the system's evolution.[164] In fact, the temporal horizon of Ljapunov describes the temporary memory of the system.[165]

Figure: 5 Ljapunov's Temporal Frames
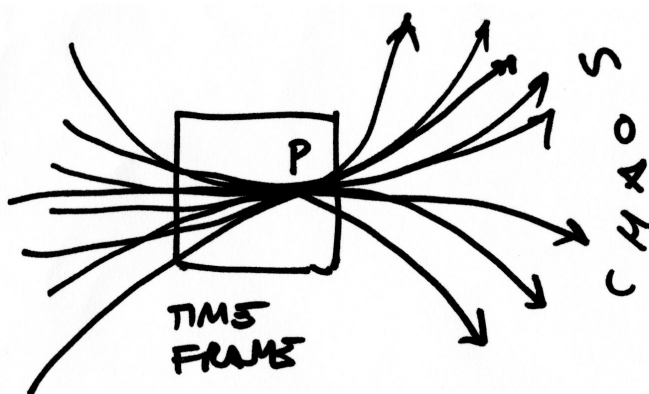
Time becomes at once more real and less independent of matter; it is progressively integrated in the definition of the logic of sense in the present, rather than acting as an external dimension. As the roughness of measurement constitutes a distance between information and probability, which becomes a measure of entropy,[166] the chain of

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[163] Cf. Prigogine, *The End of Certainty*, 84. The finite predictability of Ljapunov's temporal frames evokes the arguments Wittgenstein developed regarding the precision of the *proper name* in the representation of reality. The limited definition, or *fuzziness*, in the definition of reality of Ljapunov's horizon is reflected in the suffix "ish" adopted by Wittgenstein as the logic of language in its entirety; this is also parallel to Poincaré's coarseness of measure and the regional rather than punctual definitions this implies. Cf. Ludwig Wittgenstein, "The Proposition and its Sense," in *Philosophical Grammar*, ed. Rush Rhees, trans. Anthony Kenny (Malden, MA: Blackwell Publishing, 1980), 1–239; and Ludwig Wittgenstein, *Remarks on Colour*, ed. G.E.M. Anscombe, trans. Linda L. McAlister and Margarete Schättle (Malden, MA: Blackwell Publishing, 1979).

[164] Cf. Prigogine and Stengers, *Tra il Tempo e l'Eternità*, 96.

[165] Cf. Ibid., 113, 115.

[166] This distance is the problem exemplified by Shannon as *informational entropy*, the amount of information (or price) necessary to predict the next iteration on a series; Cf. Claude E. Shannon, "A Mathematical Theory of

transformations that takes place chronologically coincides with a logical and ontological interruption of the continuity postulated by reductionism.

Figure: 5.1 Zooming into Ljapunov's Temporal Frame
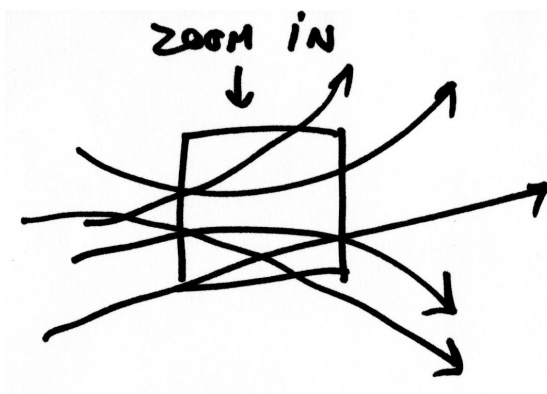
Figure 6: Ljapunov's Time is always shorter than Poincaré's Recurrence
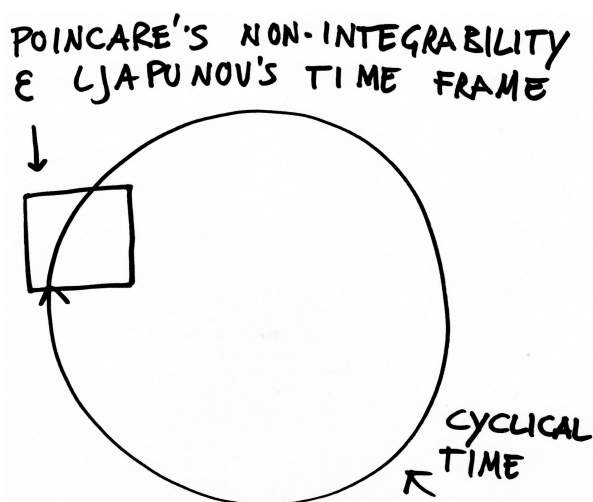
Ljapunov's temporal horizon gives an image of the correlation bubbles also from the point of view of the conservation of information. Even in classic dynamics systems where collisions create correlations, thereby contributing to the definition of the state of the

Communication," *The Bell System Technical Journal,* 27, July, October (1948), 379–423, 623–656. Hume and Wittgenstein had already stumbled upon this problem and both pointed at solutions beyond identity as the ground for the logic of sense.

system, the progressive accumulation of correlation is also undone by corruption and dispersion. The system's memory is limited and the continuity of sufficient reason local and precarious. The progressive generation and loss of information related to the correlations creates a 'fuzzy' window around the present (state of the system or universe). Initial conditions are progressively forgotten and the return to an initial state through a hypothetic inversion of velocities would quickly become lost in the absence of sufficient information.[167] Non-integrability leaves the present *open*: while more can happen, this lies beyond the horizon of predictability, not only for the observer but for matter as well.

This disassociation of the system's behaviour at or near equilibrium and far from equilibrium is key for Prigogine.[168] A system described only in terms of independent elementary particles (the individual description of classical dynamics) will differ over time from a system whose description includes the interactions among its elements. Emphasising instability exposes the difference between evolution based on the individual description and the statistical description of the ensemble.

Prigogine emphasises the great importance of Poincaré's resonances because they are a *positive proof* of the impossibility of integration.[169] Resonances constitute a radical interruption of any process of idealisation towards a pure state. Idealisation is not simply incorrect, but has become *illegitimate*.[170] Integration wilfully ignores the relevance of the interactions taking place over time; applying approximation forcibly reduces the system to elements considered as separate and static. It is the product of an essentialist paradigm derived directly from the ontological transition to the ultimate.

While this has direct implications on the commensurability of causality in the light of the uncertainty that resonances introduce in the system behaviour;[171] it also impacts on the

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[167] Rewinding the system towards its past, if possible at all, would potentially lead the system into a different past; a paradoxical result, which would make great science fiction but which, for all intents and purposes, is in fact just like the future from the point of view of the present.

[168] Cf. Stengers, Cosmopolitics, Vol.2, 165.

[169] Cf. Prigogine, *The End of Certainty*, 39.

[170] Cf. Prigogine and Stengers, *Tra il Tempo e l'Eternità*, 99.

[171] Cf. Prigogine, *The End of Certainty*, 44.

continuity between the present and the ultimate as the initial cause, ground, or limit, because it changes the image of the problem in hand. That is, the randomness of the motions resulting from perturbations or increase in energy becomes incorporated in the system, and every resonance is built on top of the previous resonances, rather than referring *directly* to the initial conditions (or ground). The chrono-logical interruption exposes an onto-logical interruption.

Resonances *sever the continuity* that is needed for the commensurability of cause-effect, effectively barring the passage from the present to the ultimate (be it ground or limit); they prohibit any process of approximation that points at idealisation toward sameness. This *strong* non-integrability on the basis of resonances severs any direct communication of the smooth transitive property that supports reductionism. Reductionism and idealisation are actually the same concept, for they both dismiss the attributes or interactions of the present as contingent, in favour of an ultimate reference point; the first seeing all possibilities contained a priori in the initial state (axioms), the second imagining that the present can always be replaced by an universally valid model - both require approximations. In the field, on the ground, in the lab, idealisation approximates; or approximation is the practice of idealisation.

This is the core of Prigogine's reconceptualisation, where the image of certainty of individual descriptions is replaced by probability as the "basic property of nature." The epistemological questions around the practice of physics shift from the problems of mediating between the concrete measure and the image of nature projected by science, to "defining the limits of validity" of Newtonian mechanics and quantum theory in existing formulations.[172]

This shift and the openness it entails need to be articulated further. While on the one hand it is the same problem that Poincaré had described in the measurement's finitude; on the other, the process of ephemeral feedback loops (bubbles) leads to the key notion of

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[172] Cf. Prigogine, *The End of Certainty*, 44.

self-constrained chance introduced by Mandelbrot: where iterating the results of previous iterations limits the influx of randomness on order. With the question of the length of a coastline, Mandelbrot had encountered a paradox, at least in Euclidean terms, since the same portion of land would vary in length depending on the unit of measure adopted.[173] The solution of a new geometry that does not measure static space, but the mode of construction of shapes in space (the fractal dimension as the pattern of distribution and a rhythm of iteration), brings to the fore a very interesting consequence. The attributes with which sense, or order, passes from *nothing to something* cannot be regarded as secondary or superficial. This has implications that reach much further than geometry. The coast of Britain would never emerge without the *specific roughness* of the dimension that articulates it. The fractal dimension is, in this light, a generative or *genetic* dimension.[174]

2.6 Self-Constrained Chance

Chaos has tempted many thinkers as a solution for finally disposing of sufficient reason, as the linear logic that keeps sense enclosed in an integrable and totalised territory. However, these attempts often fail to grasp the fundamental importance of the temporality intrinsic to non-linear systems. If the emphasis falls on the dualism order-chaos, as if these were bordering realms separated by a well-defined frontier, the consequence would be an image of chaos projected as constantly *tangent* to the order of the present. A quasi-metaphysical interpretation, on the verge of ontologising chaos by identifying it with a vague infinity, which ignores the relevance of the history (genealogies) that has led to the organisation of *this* present. In this view, ontological reductionism would once again arbitrarily exercise a transitive property, thereby approximating, smoothing, and smothering the complexity of the present onto the *ultimate*.

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[173] Cf. Benoit Mandelbrot, "How Long is the Coast of Britain?" in *The Fractal Geometry of Nature*, 25–33.

[174] This genetic logic will be discussed in dept on Chapter 4; suffice here to say that existence is never pure; differentiation is never pure and cannot be abstracted into radical difference. A condition, a *constraint* is needed. The present needs a degree of roughness to come to presence. Any purely ontological explanation, that disregards attributes as inessential is both hollow and illegitimate.

The risk is presenting the potentially infinite bifurcations of chaotic behaviours as a horizon of wildly open randomness where the *possible* and *Being* converge; conflating specific possibilities with ontological *difference*.[175] However, assimilating chance and random bifurcations with the ontological ultimate clashes with the very notion of chaos; not because chance has no play in the emergence of the organization of the present, but because projecting it as the ultimate is an operation internal to the very paradigm of linear ontology that chaotic behaviours undermine, and therefore cannot be adopted as their explanation.

Resonances introduce *uncertainty*. Yet, this is not total disorder and should not be interpreted as the ontological limit. Uncertainty is generated by a discontinuity in the linearity of sufficient reason, where the symmetry of commensurability is broken; it is not the opening of an abyss of pure chance. Indeed, there is nothing *pure* in the event of emergence. On the contrary, its processes are precisely the radically impure, local and contingent. The chance that enters chaotic behaviours during resonances is *self-constrained*. Any process open to chaos is also framed and shaped by the specificity of the process and its history.

Resonances produce uncertainty only from the point of view of determinism, which sees the interruption of commensurability as the negation of its logic. Instead, what takes place in chaotic fugues is not negative but *positive*. Uncertainty is interpreted as a negative problem to be avoided only within a paradigm that conceptualises the possible as a priori and can thereby only present it as either *predictable* or *unpredictable*; that is distributed in a conceptual space shaped by integrability. Instead, the exercise that self-constrained chance requires is one of thinking *from the present*, rather than from the foundations or the lack thereof; thinking the *relevance* of the here and now, rather than the *idealisation* implied by reductionism.

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[175] The most relevant example here is the interpretation of chaos in Deleuze and Guattari's *What is Philosophy*, where they make explicit reference to Prigogine and Stengers' *Tra il Tempo e l'Eternità* for their formulation of chaos as difference. Cf. Gilles Deleuze and Felix Guattari, "Functive Concepts" and "From Chaos to the Brain," in *What Is Philosophy*, trans. Graham Burchell and Hugh Tomlison (London: Verso, 2011), 117–134 and 201–218.

Prigogine and Stengers here turn to Mandelbrot's fractal geometry.[176] Fractal dimensions develop the problem of finite measurement highlighted by Poincaré in a new way. The impossibility of absolute precision limits any definition to a region, rather than a point; the distribution and behaviour inside such region is an "indefinite multiplicity" impossible to calculate at individual level. This is the threshold beyond which chance sets in, and predictability is framed by the horizon of Ljapunov. However, Mandelbrot was able to show that chance does not mark a threshold of indefinite vagueness. A generic "invocation of chance" as a new ontological solution for groundless ground would amount to an "empty gesture."[177] While the return to the *same* of linear dynamics is no longer possible, the recurrence of the *similar* is not devoid of order. However, only the "actual description" of the specific fractal dimension ruling a given process can offer realistic representation of the organisation of matter and sense. Generalisations that reduce all behaviours to the same fundamental laws are no longer meaningful. Fractal dimensions constrain chance; they shape and give a pattern to that which is below the threshold of measure, as much as to the macroscopic.[178] As will be seen in Chapter 4, here the notion of *dimension* comes under scrutiny; by shifting from the Cartesian external coordinates to the fractal dimensions, which are both genetic and inseparable from the material processes, dimensions become a form of *roughness* that is both the form and logic of *presence*.[179]

Chance is constrained on two counts. On the one hand, chaotic bifurcations follow a *fractal* ramification;[180] they are not free dispersions but are governed by a dimension specific to the process, which sets a pattern of distribution and a rhythm of iteration. The fractal dimension controls the proliferation with a pattern that is both *spatial* and *temporal* and yet is *site specific*; randomness is restricted within the pattern generated by this fractal

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[176] Cf. Prigogine and Stengers, *Tra il Tempo e l'Eternità*, 74, 72–75; and Prigogine, *The End of Certainty*, 38. Cf. also Mandelbrot, *The Fractal Geometry of Nature*.

[177] Cf. Mandelbrot, *The Fractal Geometry of Nature*, 203.

[178] Cf. Ibid., 201.

[179] Cf. Mandelbrot, "Dimension, Symmetry, Divergence," in *The Fractal Geometry of Nature*, 14–19.

[180] Cf. Prigogine and Stengers, *Tra il Tempo e l'Eternità*, 72–75; Gribbin, "Chaos out of Order," in *Deep Simplicity*, 70–103; and in particular Feigenbaum's bifurcations, Cf. Gleick, "Universality," in *Chaos*, 157–187.

dimension. On the other hand, such iterations are "recursive interpolations," feedback loops where *results* become *parameters* for the following iteration, hence intrinsically self-restricting.[181] Therefore, uncertainty is not opening the systems to the absolute possible, but articulates a history-specific set of joints.

The "irregularity" encountered in nature, Mandelbrot points out, can be measured by "the right amount of chance."[182] In conditions of instability, the fluctuations that naturally happen in a system may lead to bifurcations. The system chooses at random among the possible bifurcation branches, however, the options available are not themselves random, but determined by the fractal dimension that rules their multiplication. Moreover, when accelerating resonances push bifurcations to infinity, the variations may be small enough to fall below the threshold of measure, as per Poincaré's definition of chance (the infinite amount of possible evolutions contained in the finite amount of phase space). However the pattern remains rational.[183] The choice is constrained by the very mechanics of the system, effectively locked in a logic, certainly different from the commensurability of determinism, but not abandoned to total arbitrariness. The *roughness* of natural shapes and processes is highly regular (simply not governed by Euclidean pure forms).

The second aspect of constrained chance is that while the fractal dimension directly rules the distribution of bifurcations, the temporal aspect is defined by the "recursive interpolations" of such dimension where bifurcations are generated.[184] The recursiveness of fractals is of fundamental importance in the reconceptualisation of the image of time emerging from Prigogine's proposal. It also shows that in the correlation bubbles causality

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[181] Mandelbrot, *The Fractal Geometry of Nature*, 327.

[182] Mandelbrot clarifies this concept explaining that "acceptable random curves," that is real curves as coastlines for instance, present an *irregularity* within the fractal dimension that can be obtained only with the "right amount of chance," "merely varying at random the shapes, the sizes, and the order of a coastline's parts, one tends to be left with pieces that will not fit together." Cf. Mandelbrot "Chance As A Tool In Model Making," in *The Fractal Geometry of Nature*, 200–204.

[183] Cf. Gribbin, *Deep Simplicity*, 70. The term "rational" must be taken with some caution. Gribbin adopts the expression "deterministic chaos" generally accepted by physics. Yet, this should not evoke the same linearity of classic dynamics, albeit beyond measurability; rather, *rationality* here implies the existence of a logic that includes probability, while the notion of deterministic chaos is an "over–idealisation." Cf. Prigogine, *The End of Certainty*, 95, 154–155; and Stengers, *Cosmopolitics* Vol.1, 157–161.

[184] Cf. Mandelbrot, *The Fractal Geometry of Nature*, 327.

as well as chance are limited by the local organisation of matter and framed by the history of the process. This prevents a reduction to ground as well as passing to the limit (the two interpretations of the ultimate), but also poses an intrinsic limit to the identification of chance with an ontological horizon.

A regime of recursive interpolations is constrained by the very feedback loop of the process. Where *results* become *parameters* for the next iteration, the reduction to initial conditions is impossible; there can be no direct passage to the absolute reference of fundamental laws, axioms or identity. The reference frame keeps changing at the same pace as events develop; the fractal dimension is in direct relation to Ljapunov's temporal horizon, the window of predictability being inversely proportional to the fractal exponent. The impossibility of reducing or idealising the system towards the totality expressed by the *same* imposes the events at the local level as determinant for the evolution of the system. Each loop, or bubble, is limited by the articulation generated in the previous loop and provides a potential platform for the next loop. Ontological identity, rather than being given a priori, emerges as the history of the system unfolds. At each interpolation, the random choice among bifurcations injects a degree of chance, which constitutes an ontological interruption. It is therefore impossible to calculate the evolution of the system faster than events happen in real time.[185]

The intervention of Mandelbrot is of great importance for understanding the ontological consequences of non-integrability. He was able to show *why* the fact that resonances open the system to chance does not entail opening the floodgate of disorder and is instead a local event.[186] "Chance –Mandelbrot writes- fits smoothly into recursive methods" and fractals have a great importance in the mathematical representations of statistical physics.[187] Chance, Mandelbrot clarifies, is necessary to explain the "strong

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[185] Cf. Gribbin, *Deep Simplicity*, 7.

[186] Cf. Mandelbrot "Chance As A Tool In Model Making," in *The Fractal Geometry of Nature*, 200–204.

[187] Cf. Mandelbrot, *The Fractal geometry of Nature*, 201.

degree of irregularity" encountered in the present.[188] "Iterations are essential for fractals," yet the effect that chance has on the recursiveness, from bifurcation set to bifurcation set, is not recognised as it should be ("widely underestimated"), and -it could be added- it is overemphasised generically in the haste to ontologise at all costs;[189] both overlook the actual degree of chance that impacts recursive processes. This is of great relevance for the purpose of explaining non-integrability: the countless loops or interpolations that lead from the microscopic level to the macroscopic present are "ill-explained intermediaries" affected by chance at each round. Iterations' loops add fresh details at each round and the interference of chance remains constant from microscopic to macroscopic levels. The laws of mechanics may effect microscopic motions directly, but they do not take into account the chance that leaks into the system in its interpolations.

The fundamental point is that in the distribution of the pattern of bifurcations "late stages of the construction are constrained by the outcome of earlier stages, and or chance is strongly self-constrained by the geometry of space," that is randomness in the choice is restrained to the existing organization of matter, thereby interrupting not only the continuity of sufficient reason, but most importantly the smooth passage to the limit of any ontological idealisation, including difference.[190]

Mandelbrot's warning against an empty invocation of chance becomes clearer. In the feedback loop between bifurcations and randomness, probability does not present all the possible options of evolution *at once.* On the contrary, it is probability that is generated locally and chronologically, reconfigured each time the system interpolates its results. The history of the system defines the organization and the distribution of the present, and this, in turn, is the pattern of possible bifurcations. This pattern, or roughness, is the shape of the system, but is also the degree and shape of openness that is vulnerable to chance, the

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[188] Mandelbrot is concerned with the geometry of real shapes rather than mathematical objects. This leads him to study how chance can interfere with the pure recursive iterations of fractal dimensions and alters their curves to produce the shapes encountered in nature. While for Prigogine, fractal dimensions permit a representation that satisfies the needs of statistical calculations in ways that the mathematics of determinism could not do.

[189] Cf. Mandelbrot, *The Fractal Geometry of Nature*, 180 and 201, respectively.

[190] Cf. Mandelbrot, *The Fractal geometry of Nature*, 203.

territory on which randomness can act. In other words there is no distinction between the pattern of the present and its possibilities, for there is nothing reachable beyond the history of the present.[191] The self-constrained character of the process bars the passage to the limit of an ontological generalisation and dictates the finitude of the present. That is, this barrier is generated by the process, rather than imposed externally. The systems may be entirely random inside its dimensions, but its dimensions are neither random nor absolute.

It then becomes evident that it is not just an analogy that links the bubbles described by Prigogine to fractals. As explained earlier, far from equilibrium, correlations may lead to macroscopic phenomena that may in their turn give rise to further phenomena. Bubbles too are loops where *results* become *parameters* for the following iteration; that is, the local coherence of sets of correlations may act as a platform, ground or cause, for other phenomena to emerge. While this would appear to follow linear determinism, such sets or bubbles may be ephemeral: just as they have emerged they can vanish. Thereby the *cause* of macroscopic events may vanish; bifurcations are bridges that cannot be crossed backward for they have disappeared. The continuity and linearity of sufficient reason is thereby interrupted without appeal.

Such self-constrained chance constantly inherited by the system constitutes the entropy barrier that prevents reductionism. Dynamics itself is here subtracting the legitimization for the ontological reductionism that would impose a passage from the contingent to the ultimate. Physics, in Prigogine and Stengers' formulation, is no longer supporting ontology with a material example for the transitive logic that guarantees the smooth transition to the ultimate; it cannot be called upon to confirm ontology's claims.

In this regime of self-constrained chance and self-constrained results, the process never reaches the horizon of the pure possible, or difference. There is no absolute edge or limit condition as the ontological ultimate. Rather the process develops along a segment between zero and one: never total randomness, never complete determinism; never the

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[191] This critical point will be discussed in detail in Chapter 4.

infinity of possibility and never total actualisation. The segment hovers between zero and one, constantly changing the precision of its definition following the interpolations, while maintaining an average distance from the extremes. In fact, these extreme poles are the idealisation pointed out by Prigogine and Stengers as illegitimate. With fractals, the *ultimate has lost all relevance* and the present is *finite*.[192]

This finite locality is also a radical heterogeneity. Bifurcating branches have no communication with other diverging branches for they are not happening in a space of possibility. Indeed, heterogeneity is at the root of the irreducibility that bars the totalization of the possible and the overall view of an ideal external observer. It is also not embedded in the pure difference as the horizon of the contingent present. Heterogeneity is what can – and does- exist, given the parameters of the iterations that have occurred until now. In this sense, if a metaphor is allowed, heterogeneity is nothing but a *blind locality* of events and their laws. A blind locality means an *open* organisation; the present is open. The finite is non-totalisable because it is irreducible to a unitary ontology. This should not be confused with the divergence of incompossible universes that Leibniz proposed. Incompossibility functions precisely on the ground of a totality organised by the principle of non-contradiction for the divine gaze. This passage is precisely what is barred by self-constraints.[193]

This amounts to turning the logic of sense *inside out*. The coherence of the present is not representation nor it is a simulacrum, but a logic whose horizon is out of focus; a present locked in time because the passage to the ontological space projected a priori is interrupted. Only a Euclidean space of consistent possibilities, tested and confirmed a priori, could simultaneously offer the all possibles to one ideal gaze.[194]

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[192] As it was seen in the introduction, this notion of finitude opposes Meillassoux's proposition of a new absolute albeit non–metaphysical ground. Here the present is finite because it exists without relation to the absolute, and without the need to be legitimized by it.

[193] Supra: as will be seen later in the Chapter, this heterogeneity bears strong similarities with Gödel incompleteness, leading to a form of undecidability that is dynamic and genetic; in turn this overcomes non–contraction as the only principle that rules compossibility.

[194] This notion of coherence without a priori will be discussed in detail in the light of Gödel and Leibniz interpretation of consistency and finitude.

Yet, it is not enough to shift the ontological emphasis on time. Dialectics, the time-based ontology per excellence, does not really leave a spatial paradigm; it is nothing but a process of progressive recognition of that which is already *there*. The hope of Bergson of an absolute time beyond measurement is frustrated for the same reason. In fact, with the introduction of entropy as a universal constant, Prigogine has shown that even the idealisation of an absolute time, thinkable ontologically beyond the limit of scientific measurement, is not a viable option, because to be absolute, unique and unitary, the information of such time would have to break the speed of light constant.[195] Nor should this finite logic be interpreted as immanence; rather, it is *openness*. The present is open: the initial conditions (or ground) are progressively forgotten and the past and the future cannot be thought of as *points*.

Finitude is firstly incommensurability. The present emerges as entirely *else* from identity. Non-integrability shows that the coherence is neither the product of a consistent logic, nor is it deducible from fundamental laws or matter, as the linear dynamics of determinism. The entropy barrier that emerges here is chronological as much as ontological irreducibility. Prigogine shows that the temporal element is intrinsic to the logic of coherence. The present is a temporal product, rather than the representation of an origin or end, or tangent to the untimely virtual. Finite precision leads to chaos. Chaos makes the present irreducible, therefore finite in ontological terms. The inclusion of a degree of randomness in the causality chain prevents retracing the process; the route to the absolute is barred by the very history that has developed the system. Thermodynamic irreversibility is ontological irreducibility. The uncertainty that resonances introduce in the system is in fact the generation of a *degree of roughness*, which determines its evolution and shape, and is not negative but fundamentally *positive*.

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[195] This was the famous hurdle on which Bergson stumbled in his debate with Einstein. Bergson's hope was precisely to retain the possibility of idealization in spite of the impossibility proved by measurement. Cf. Bergson, "Appendix V, Discussion with Einstein," in *Duration and Simultaneity*, 154–159.

The image of the present is inverted. It cannot be overemphasised how what is at stake is a notion of surface that is not *superficial*; or –which is the same- a notion of aesthetics that is not the contingent and ephemeral appearance to the senses of fundamental principles, concepts, or laws of matter. The surface, that which gives itself as presence, is a network of local relations that neither express nor represent identity. It is a peculiar form of contingency because the necessary level is not unreachable but irrelevant. Like Epicurean gods, the axioms are indifferent to the present. More importantly, it is the *present that is indifferent to the ultimate*. Both the ground and the limit have lost absolute relevance for the organisation of the present: unable to provide information for every stage of the system's evolution; incapable of providing a compressed definition of the system's possible configurations. The image of time becomes identified with the fractal pattern generated by recursive interpolations.

With Mandelbrot's notion of self-constrained chance it is possible to extend Prigogine and Stengers' claim that a *system has a past* from macroscopic biochemistry to the statistical mathematical formulation of systems in general.[196] However, the possibility of a unitary ontological description ends here. The claim made here is precisely *not a new universal*.[197] The fact, "history depends on randomness" introduces an irreducible element, which is also a non-idealisable element.[198] Self-constrained chance is at the root of this irreducibility. Prigogine and Stengers had shown how irreversibility emerges from instability: irreversibility implies an intrinsic randomness, which in turn stems from instability.[199] They did not emphasise, however, how this irreversibility is also an ontological irreducibility that cuts off both the ground and the limit. In the recursive interpolations where results turn into parameters, randomness has a limited effect, because there is a limited amount of order that can be affected. In the feedback loop at play here, the present state is multiplied by

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[196] Cf. Prigogine and Stengers, *Order out of Chaos*, 153.

[197] Cf. Ibid., 299.

[198] Cf. Ibid., 147, 170. They specify: "There is no longer any *universally* valid *law* from which the overall behaviour of the system can be deduced. Each system is a separated case;" Cf. Ibid., 144–145. This non-universality is at the root of the counter-actualisation of dynamics that stems from Prigogine's work.

[199] Cf. Ibid., 260–280.

itself rather than confronting the absolute possibility of being or difference. Chaotic behaviour is not a process of actualisation, rather only the evolution of finite and open contingency. Bifurcations may be undecidable, yet undecidability is limited by the existing organisation of the present. This is not to be grasped as a barrier that holds randomness at a distance or contains it; there is no defence or resistance against undecidability. On the contrary, *self-constrained* means that *iterating finite sets of dimensions necessarily produces finite and positive dimensions*: where results become parameters, each iteration has only a finite and local number of possibilities to implement and randomness can effect only the finite and local organisation. That is, the contingency of present can offer only a limited amount of order to randomness; likewise, randomness can only act on the limited pattern of information defined by the finitude of measurement encountered by Poincaré. Bifurcations do not bring absolute undecidability. In fact, undecidability can never be absolute, but is itself constrained by the results of the feedback loop.

In this sense emergence is not reducible. That is, not only are its products not reducible, but it is the very process of emergence that cannot be universalized. To present this otherwise would mean to fall victim to the onto-theological paradigm that forces ontological idealisation in all instances; that is, push the present towards a totalising identity by putting it in direct relation with the boundary definition of the ultimate. This brings the problem of defining heterogeneity back to the definition of chaos, the exponential divergence over time of one region or state identified by the same description.[200] The ontologisation of chaos as a horizon of ever-returning possibility, or difference, is an illegitimate idealisation. As Prigogine reiterates, chaotic behaviour does not constitute a new continuity.[201] Chaos is neither the zero of determination nor the infinity of possibility; it is instead a *local*, *heterogeneous* and *open* behaviour. Heterogeneity is precisely the behaviour in conditions not bound by a continuous definition. Openness is not a *property*,

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[200] Cf. Prigogine and Stengers, *Tra il Tempo e l'Eternità*, 75.

[201] Cf. "The fact that there are bifurcations everywhere does not constitute a new continuity," in Prigogine, 22nd Solvay interview, https://www.youtube.com/watch?v=MnD0IlBvgO4, accessed on June 6, 2016.

but the finite and yet unbound condition of the present. Chaos is not a state or a place, but a behaviour; heterogeneity and locality are attributes of the chaotic behaviour *when* this happens. It is not possible to speak of heterogeneity and locality per se.[202] Most importantly, the *fact that* there are bifurcations everywhere does not constitute a new continuity. In chaotic behaviours, heterogeneity and incommensurability cannot be unified into *facticity*. Indeed, this would just amount to a regression to infinity, which only an arbitrary act could stop. Ontologising these behaviours as a place of possibility is indeed the metaphysical operation of Meillassoux, as shown in the introduction; but also the return to identity latent in Deleuze virtual, which will be discussed in Chapter 3.

Perhaps it is important to emphasise how such openness is somewhat passive, rather than a well-defined property. In fact, it is not identified from an external position, which could see both the system and its boundary, and with that recognise the possibilities implicit in the system's definition. On the contrary, openness is akin to an event: when change presents itself, it finds that it can organise itself differently. This was not inscribed in the previous definition of its order, but emerges from the system's interactions. This heterogeneous openness points to the epistemological problems raised by Prigogine's work and leads to the counter-actualisation of physics that Isabelle Stengers will discuss in *Cosmopolitics*. While Stengers tends to interpret this counter-actualisation in the light of Deleuze's returning difference, thereby posing it as a horizon of ontological possibility, the thesis tries to follow this finitude to its extreme consequences, exploring a non-ontological logic of sense.

2.7 Augmented Causality

The heterogeneity of chaotic behaviours just seen can be articulated via Leibniz's notion of finitude. The emergence of positive finitude is the consequence of the simple

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[202] In *Cosmopolitics* Stengers stresses that the laws of chaos are not universal; Cf. "In The Name of the Arrow of Time: Prigogine's Challenge," in *Cosmopolitics*, Vol.2 105–204. In fact, the laws of chaos are laws of the surface, which belong to the whole of the system, Cf. Prigogine, *The End of Certainty*, 95–105.

iterations of imperfect monads. There is not a passage from pure chance to order; rather it is a progress both continuous and discontinuous where some existing order implies some site-specific randomness; an incomplete or open organization that can change, without there being any ontologisation of this change, any form or possibility in which such change would unravel, evolve, or expand. As was seen, a chaotic process does not involve an external position, such as Leibniz's God, that would permit the evaluation of all possible combinations and choose the best. Chaotic processes are locked in the locality of one branch of compossibility. Yet, as will be see in Chapter 3, bifurcations do not imply the exclusion based on non-contradiction, as one would find if compossibility would be measured against the a priori totality of the possible.

In §32 of the Monadology Leibniz writes that sufficient reason is the explanation (reason) why *things are thus and not otherwise*. Nothing exists without a reason, so the question *why something rather than nothing* is excluded by this very principle from the realm of contingent existence and left to abstraction; it remains only a metaphysical question for the passage from the divine mind to the finite world, where the struggle for existence and the success in coming into existence depends on the "consequences" – the economic principle of producing the "most reality" and "most significance" out of the simplest causes.[203] This shows that nothing exists per se (but God), everything else exists with dimensions, embedded in a network of causes and effects, inputs and consequences, that are its dimensions as much as define its possibilities, and hence cause future effects. Therefore, the pattern of the present dictated by its history is both the degree of openness of the system and, which is the same, the degree of possibility the system or present has. The pattern of the present, generated throughout its history, is both the dimensions and

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[203] Cf. Gottfried Wilhelm Leibniz, §196, §201, §206, in *The Theodicy*, 252–260. Isabelle Stengers does not take this reference to relevance into account in her depiction of Leibniz as the champion of linear causality. It seems instead that the logic of compossibility is offering interesting departure points for a logic of coherence in finitude. Cf. Prigogine and Stengers, "Dynamics from Leibniz to Lucretius, "in Serres, *Hermes*, 135–158; Prigogine and Stengers, *Tra il Tempo e l'Eternità*, 28–33 and 36–44.

possibilities of the present (dimensionality).[204] In the light of what was said above, such dimensions constitute the sufficient reason for what is to come.

This is a chain loop or reciprocity that conditions local events without aspiring to lay out a totalising chain of sufficient reason that moves from some original input. On the contrary, it is a loop that prevents linear commensurability and shows that without determination there can be no existence; pure existence is -once again- an arbitrary idealisation. To be clear, the point is not to deny chronological causes, but to highlight how any potential initial cause can be reached only through the negotiation of each and every intermediary interpolation that has taken place since the initial conditions. In parallel: things come into existence only with a sufficient reason; that is, a dimension. The question *why something rather than nothing* is left for divine metaphysics, it cannot explain any of the order or logic of organization of the world. Attributes are not secondary, or only superficially aesthetic, but part of the *is*; the contingent defines the necessary and yet does not install a new hierarchy in its favour. This is perhaps the deep message of *openness*. In the question *how are things thus rather than otherwise* sufficient reason is not a linear causality, chronological, but a retroactive synthesis - and this still retains an excessive affinity to ontology, concentrating only on the coming and remaining into existence (*refrain*, *repetition*, sticking). Interpreting the notion of ontological emergence proposed by Stuart Kauffmann in the light of the questions of *relevance* and *mattering* rather than identity offers a very interesting path forward.[205]

This is where the patterns of the fractal distribution followed by bifurcations pose a finite existence to the universe of sense. They constitute a sufficient reason for the choice of one order versus another. Yet, there is no absolute birth into existence from an absolute source of existence before attributes are displayed. Non-integrability has cut off the original

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[204] The concept of *dimensionality* mentioned here is the topic of Chapter 4.

[205] Cf. Stuart A. Kauffman, *Reinventing the Sacred: A New View of Science, Reason, and Religion* (New York, NY: Basic Books, 2010). Kauffman work on possibility will be the topic of Chapter 3. Stengers' *relevance* and Barad's *mattering* or *diffraction* will be discussed in Chapter 4.

causes of such sufficient reason (God's initial input).[206] Reason is a problem for the present to negotiate.

Isabelle Stengers points out that in the "new fiction" of phase space, dynamic systems and their possible perturbations are formulated together; or, phase space exposes the risk of perturbations and their resonances as intrinsic to the description of a dynamic system.[207] In fact, resonances are a breaking point for both physics and epistemology. An observer endowed with infinite power could ideally still overcome a formulation of non-integrability derived only from the finitude of measurement, while the discovery of unstable dynamic systems re-opens the discussion on the determinism that informed dynamics from its origin.[208] The individual description that supports determinism is confined to the special case of equilibrium states. Here instead, probability becomes primary; yet, it cannot act as the "primitive object" of physics as trajectories did.

The conceptual *structure* of dynamics has shifted. In fact the very notion of "primitive element" is not longer tenable. What replaces this paradigm is a *segment* stretching between low instability and "*transient* interactions," where at one end diffusion in phase space is negligible and the deviation from the initial trajectory re-absorbed, while at the other end conditions of "*persistent* interactions" with high levels of energy dissipation (instability) make diffusion prevail.[209] Measuring the degree of instability will give the probability distribution for the evolution of the system. This, Prigogine concludes, undermines both Newtonian and the "orthodox" quantum descriptions of mechanics, since what has become valid beyond few very special conditions of stability is a probabilistic

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[206] Cf. G.W. Leibniz, "On the ultimate origination of things," in *The Shorter Leibniz Texts*, ed. and trans. Lloyd Strickland (London, Continuum, 2006), 31–38.

[207] Cf. Stengers, *Cosmopolitics*, Vol.1, 157–161.

[208] Cf. Prigogine and Stengers, *Tra il Tempo e l'Eternità*, 8. Stengers emphasises the importance Prigogine attributes to large Poincaré systems. They act as the counter-instances that for Kuhn induce a shift in the existing paradigm. She writes: "Large Poincaré systems become the counter model" of reference "capable of assigning its dynamic meaning to the arrow of time;" Cf. Stengers, *Cosmopolitics*, Vol.2, 179.

[209] Cf. Prigogine, *The End of Certainty*, 44.

description that cannot be reduced to fundamental independent elements (not integrable).[210]

Chance is a new rationality, Prigogine writes. The laws of chaos function and apply beyond Newton's laws and probability is a new basic element of dynamics.[211] Laws of chaos are formulated only at the level of ensembles.[212] Yet, this does not mean that they are to be linearly added to the dynamics laws implementing them without contradiction. They are instead real primary properties of unstable systems. Far from equilibrium, laws and logic are local and heterogeneous; different chaotic behaviours develop heterogeneous properties. The present is a surface that cannot be integrated and must be considered in its entirety. The behaviour that takes place in resonances is site specific.[213] This specificity, or locality, is the product of augmented causality, where sufficient reason, rather than respecting the symmetry of causation, diverges into local and augmented forms of coherence.[214] The effect of this diffusion constitutes an *entropy barrier*, where infinite energy/information would be necessary to retrace the process of the system that has augmented its properties because of randomness.[215] Probability is built into the very definition of the system.[216]

Dynamic systems cannot all be described by the same type of equations. The equivalence between equilibrium and non-equilibrium states is broken; not only can a dynamic system not be represented as a "perturbed integrable system," but the very universality of fundamental laws to which all events should be reduced is undermined.[217] Epistemologically, this rupture in the homogeneity of the representation of nature re-emphasizes locality and finitude of the practices of science and points to the ontological

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[210] Cf. Ibid., 45; and "A Unified Formulation of Quantum Theory," Ibid., 129–154.

[211] Cf. Ibid., 154–155 and 126.

[212] Cf. Ibid., 87.

[213] Cf. Ibid., 90–91.

[214] Prigogine and Stengers briefly mention a form of "enriched causality" in *Tra il Tempo e l'Eternità* 59. It is important to develop this concept further.

[215] Cf. Prigogine and Stengers, "The Entropy Barrier," in *Order out of Chaos*, 295–297.

[216] Cf. Stengers, *Cosmopolitics*, Vol.1, 158.

[217] Cf. Ibid., 161.

impact of the *counter-actualization* of physics that Stengers discusses in *Cosmopolitics*. The relevance of the work of Ilya Prigogine is to have developed the limitation of measurement towards a reinterpretation of the notion of time in physics. This however is not limited to a legitimization of thermodynamics, rather it has a radical impact on ontology. Indeed, altering the image of time does not leave untouched the logic that organizes the present. A present interpreted as the expression of the ultimate, ground or limit, is always ephemeral, always the image of a cause or an end, a contingent and material epi-phenomenon confined on the lower rungs of a hierarchy that sees the ultimate framing the discourse, as the *concept* of the present object, even when such a concept is pure difference. Prigogine's interpretation turns this on its head.

Progressively, Ljapunov's temporal frames provide a new image of the present, extending their significance beyond statistical dynamics to reach ontology. Yet, as in the case of the correlation bubbles, this must not be read as an ontological metaphor. While the temporal horizon is a visualisation of the limits of predictability, such limits also describe the domain of validity and the horizon of relevance of present events, which introduces the problem of *mattering* that will be discussed in Chapter 4.

This new irreversible understanding of time provides a support and a logic for the emergence of dissipative structures that Prigogine and Stengers had shown as the core of all processes of self-organization and the emergence of life.[218] Moreover, describing the *present* as a non-integrable pattern has a direct and radical impact on ontology, turning on its head the hierarchy between the abstraction of Being and the contingent presence of the given. A non-integrable universe of sense cannot be reduced to a priori axioms or idealised towards a metaphysical realm without erasing the information generated by the relations

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[218] Cf. Prigogine and Stengers, "The Science of Complexity," in *Order out Of Chaos*, 103–209; and Nicolis and Prigogine *Exploring Complexity*, 6–44. Regarding the image of time, Isabelle Stengers offers a detailed account of how the technology of measuring time (clocks) has an influence on its image, while here the emphasis is one the importance the image of matter has in shaping time. Cf. Didier Gille and Isabelle Stengers, "Time and Representation," in Isabelle Stengers, *Power and Invention, Situating Science*, trans. Paul Bains (Minneapolis: University of Minnesota Press, 1997), 177–212.

taking place through its history; the present emerges as local and site specific.[219] The image of time comes to coincide with *finitude* and, most importantly, the notion of *possibility* becomes disassociated from *identity*. Indeed, in a regime governed by probabilities rather than determinism, possibilities come logically and chronologically *before* identity.[220]

In the light of the inevitable limits in the definition of a fact highlighted by Poincaré, the presence of the given is always a finite sequence of decimals rather than absolute. The finite measurement or description defines a window of precision, which does not only affect the probabilities of evolution, but crucially *shapes the pattern of the possibility of the present*. That is, by describing its dimensions it defines its possibilities. Irreducibility makes the present a pattern with no reference to axioms or absolute but *shaped by its own finitude*. Yet, this limit does not express a partial or differential identity. This new image of time *turns the image of possibility inside out*. This is precisely because finitude is not imposed by an external limit, such as negation for instance, or raised by radical difference from indeterminacy, but stems from the impossibility of totalization and idealisation that emerges from the very property of physics (the entropy barrier posed by matter itself).[221]

This returns the problem to the impossibility of recurrence, where the cycle that would calculate all possibilities would be much larger than the universe that is being

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[219] Supra: the logic of emergence and how it no longer obeys the concept of identity will be discussed in Chapter 3; it can be already pointed out that this non–integrability converges on Gödel's incompleteness and Chaitin's analysis of non–compressibility of description.

[220] Supra: To quickly glance towards the conclusions, this gives one more spin to the reversal that Heidegger had achieved between Being and Identity, showing that the sense of Being and beings is embedded in their relation as their proper place; here instead relations are plural and heterogeneous, their emergence is open onto the relevance of their finite patterns.

[221] While the image of time seems to coincide more and more with history, it must be pointed out that at the end of this path, nor Prigogine nor Stengers are able to let go entirely of an absolute image of time (thought and pictured as an absolute dimension outside events), heirs as they are of Bergson and his attempt to defend temporality and duration against the a–temporal representation that science gives of nature, as much as they are of Boltzmann. Prigogine, instead of embracing to the full the consequences of entropy as the measure of change, will maintain a classic image of time, as the absolute background, before and outside all events. While Stengers, in a subtler move, by embracing Deleuzean ontology implicitly identifies time with the pure possibility of the virtual (as the event that events can happen, as Deleuze names the ontological-temporal *receptacle* in *The Logic of Sense*.) These are metaphysical turns that the thesis does not share. It is indeed possible to develop a different ontological interpretation of this notion of finitude without the need of the external support of a ground or embedding it in difference.

calculated.[222] The implication for both science and ontology could not be greater: a *definition of the universe cannot be smaller than the universe itself*. This is valid for any definition. Identity, rather than being representable through axioms or compressible in a code, can only be as large as the entire system, and its evolution describable only through its history.[223]

Prigogine and Gödel - Prigogine had emphasised how Poincaré's resonances provide a *positive proof* for non-integrability, rather than being a frustrated attempt to reach the complete definition of the system.[224] Systems with infinite numbers of elements cannot be proved a priori on the basis of their initial description. This is parallel to Gödel's proof of incompleteness where "a proof can be given of the impossibility of proving certain propositions within a given system."[225] This is different than the repeated failure to demonstrate something, since failure does not entail that a proof cannot be found. *Incompleteness is not the proof of another form of completeness*. The axioms of the Euclidean conceptual space, and the notion of self-evidence associated with them are shown not to be the only foundations possible. This point is key in the demise of linear ontology because it does not repeat the unitary move towards one logical solution, but exposes a certain limit specific to a given system; a limit emerging from *inside* the system.

As for Gödel, another logic is possible for guaranteeing the system's coherence. However, there is a difference. Gödel's incompleteness required a more powerful system, a further meta-language that could guarantee the certainty of the propositions of arithmetic and its inferences. Instead, in Stengers' interpretation, the counter-actualisation stemming from Prigogine's work is the opening onto an *alternative* logic, one that functions outside of any hierarchical positioning in reference to the linearity of integrability. Indeed, the

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[222] Cf. Gribbin, *Deep Simplicity*, 66–69.

[223] The impossibility of a priori compressed definition in relation to the time needed for the calculation of the evolution of the system has been addressed by Gregory Chaitin in a re-elaboration of Gödel incompleteness proof. Cf. Chaitin, *META MATH! The Quest for Omega*.

[224] Cf. Prigogine, *The End of Certainty*, 39.

[225] Cf. Ernest Nagel and James R. Newman, *Gödel's Proof* (New York, NY: New York University Press, 1986), 9–10.

dimension Prigogine adopts marks an entirely different paradigm for physics, since it includes behaviour and roughness at a fundamental level of dynamic description.

There are many points in common between Prigogine's interpretation of non-integrability and Gödel's demonstration of *incompleteness*.[226] Like Gödel, Prigogine proves the impossibility of deducing the present from initial conditions only. Also like Gödel, this is proved from inside the system; that is, it is not a limit imposed from an external authority. This is key for the notion of counter-actualisation of physics that Stengers will develop. Lastly, in parallel with Gödel, Prigogine's proof leaves physics epistemologically incomplete, or *fragile* as Stengers wrote,[227] since the homogeneity of its representation of nature is interrupted by the possibility of other sets of fundamental laws or axioms that would be equally valid although they would not produce an equivalent image of the world.[228]

However, unlike Gödel, Prigogine's incompleteness is not a somewhat frustrated ontology, yearning for a conclusion it can never reach. Rather, in Prigogine's reconceptualisation incompleteness is turned *positive*. As mentioned earlier, Prigogine develops Poincaré's non-integrability incorporating the risk and the effect of resonances in the description of the system. Instead of the individual description in stable conditions (represented by a point), probability is the primary element of mechanics (albeit not fundamental in the sense of a universal law); no longer a single independent particle, but the behaviour of the system in its entirety. This is not the same as modelling an integrable system in which perturbations would be progressively added and integrated, for this would repeat the same problem encountered by Gödel's undecidable propositions, which can be integrated at the cost of adding new axioms only to return in later iterations of the system; thus precipitating in infinite regression. Rather, in such ensemble descriptions (probability) the basic unit is not a point but a segment stretching from stability to the instability where

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[226] Cf. Kurt Gödel, *On Formally Undecidable Propositions of Principia Mathematica and Related Systems*, trans. B. Meltzer (Mineola, NY: Dover Publications, 1992).
[227] Cf. Stengers, *Cosmopolitics*, Vol.1, 4. This fragility points to the counter–actualisation of science, or at this point of the entire logical edifice of knowledge, that Stengers has addressed.
[228] Cf. Nagel and Newman, *Gödel's Proof*, 10–12.

chaotic resonances take place. The definition of such a segment will no longer be a point individuated by external coordinates, but the amplitude of the resonances; the distance from both equilibrium and total chaos (one-zero). This is a new kind of dimension that rules behaviour rather than defining a static position; it is genetic. Prigogine explains it with a fractal dimension, which belongs to matter's iteration rather than to pure space as the stage for events. Adopting a fractal dimension opens an entirely different paradigm from a priori space; a space that, it must be emphasised, was the implicit ontological consequence of thinking the equivalence of all points in a system for expressing the whole. Probability is the frequency of resonances; a degree of roughness existing at fundamental level. It is a dimension that always contains information, it is never pure (zero), but somewhere between zero and one. One begins to see that an ontological stance thinking pure existence is as arbitrary an idealisation as the abstraction of motion from the effects of friction and correlations after collisions.

In fact, a non-integrable present is *undecidable*. Its logic cannot be deduced to fundamental laws. For Gödel the proposition-present cannot be deduced a priori from the axioms and the theorems these may develop without contradiction. The image of thought functioned on the presupposition of a space defined by identity. Prigogine's work introduces a temporality that frees history and requires genealogies rather than a priori identity; it proposes a logic of sense without *space*, as this would imply a totalisation existing a priori. It steps out of Euclidean space existing per se before events. The space that Deleuze attempts to abandon because it lays out and distributes all possibilities on the base of an a priori unity, which governs the convergence of perceptions, experience, thoughts.[229] Hence there is no room left for invention, creativity, change and thought is confined to recognition; confined to ascertain that what is encountered corresponds to the concept it is supposed to confirm; a totalitarian logic. Here coordinates act as boundaries.

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[229] Cf. Deleuze, "The Image of Thought," in *Difference and Repetition*, 164–213.

Gödel demonstrates that a system cannot prove *itself* consistent (or complete); a meta-language or more powerful system is always needed to avoid the regression to infinity provoked by undecidability. From the point of view internal to the system there is only incompleteness. This is the same *barrier* encountered by Prigogine in his elaboration of Poincaré's resonances: the impossibility of totalising. Only the universe as a whole can be considered a perfectly sealed system in terms of dissipation of energy/information. However, to attain such an absolute level of definition an infinite amount of information would be necessary to avoid infinite regression; the external position of a metaphysical observer. Yet, this position is meaningless from the point of view of scientific measurement, for it sits beyond physics. As Poincaré indicated, the problem of defining the initial conditions is key to scientific approach. Likewise, Isabelle Stengers points out that "measurement is an intrinsic part of physics and not a decision of a human being." Measurement for her is an *event* that makes the universe of sense appear.[230] Without the external observer position, without a meta-language or metaphysics, the measurement and the present can only be finite. Undecidability is still a concept formulated inside a linear and consistent paradigm. Prigogine's reconceptualisation of dynamics around probability and site-specific properties instead reinterprets this impossibility as a *positive openness*. In this openness, it will be seen, the logic of the present is *transcendental*, yet this does not mean that it still functions within the space of identity, affirmed as a ground or projected retroactively as the virtual. Rather, this transcendental is intrinsically temporal and is better described as *metastability*.

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[230] In fact, Stengers opposes this event to both the *faith* of the physicist in the certainty of knowledge and the subjective opinion. This faith is beyond the "counterfactual" existence of an object per se, as d'Espagnat inteprets it: that object which is found through mathematics, but once proved gains an independent existence from the observer even if this had never performed the measurement/observation. An interpretation that is pushed to its ontological conclusions in the Speculative Realism move, where the paradoxical existence of the neutrino is raised as ontological proof. Cf. respectively: Stengers, "The Science Wars," in *Cosmopolitics,* Vol.1, 1–83 and *Cosmopolitics,* Vol.2, 158. Cf. also Bernard d'Espagnat, *On Physics and Philosophy* (Princeton: Princeton University Press, 2006), 25.

d'Espagnat on Un-certainty and Causality - *The End of Certainty* is perhaps an over-dramatised description for a much subtler concept.[231] D'Espagnat points out that the notion of the end of certainty, with regard to chaotic behaviours, depends on a restricted interpretation of certainty as *predictability*.[232] However, it is not predictability per se that is undermined by Prigogine's interpretation of chaos as a source of complexity. Indeed, what is at stake is the breaking of continuity in the commensurability of sufficient reason, which does not lead to uncertainty in the open sense of absolute chance, but rather to an a-symmetry between causes and effects that can be described as *augmented causality*; a process that produces energy dissipation in its emergence and requires increased information for its description, with entropy positive for both.[233] It is the authority of the concept of a universal identity, or law, that becomes difficult to uphold, rather than a more generic accuracy of prediction.[234]

The certainty that complexity appears to weaken is in fact of a different kind than the direct relation of cause and effect. It is a shift to open systems where the conditions required for the process of emergence are not sufficient to guarantee that such an event will take place, unless sufficient reason changes its colours. At the same time it would be simplistic to attribute this uncertainty to the intervention of *chance* as an extra ingredient; a deus ex machina that would repeat the logic of an external intervention, which only procrastinates the arrival of the ground. In fact, Prigogine had made clear that chance is not another form of causality "embedded in the deterministic framework;" indeed, it is its very

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[231] Isabelle Stengers had taken some distance from the title of her first collaboration with Prigogine (*La Nouvelle Alliance* then *Order out of Chaos*,) as excessively "prophetic," in particular when trying to articulate the different logic of the shift that involves Prigogine research as counter–actualisation, rather than a more straightforward replacement of the accepted interpretation. The point discussed here seems to be a similar case. Cf. Stengers, *Cosmopolitics,* Vol.1, 4

[232] d'Espagnat does not mention Prigogine directly, nevertheless he is quite clear: "the notion of chaos was sometimes linked to a thesis to which some writers gave the impressive name: "end of certainties." Cf. d'Espagnat, *On Physics and Philosophy*, 319.

[233] In fact, in the chrono–logical irreversibility that Prigogine presents thermodynamic entropy and Shannon's informational entropy coincide.

[234] Furthermore, d'Espagnat points out that Prigogine argument pivots on reversing the notion of equilibrium between microscopic and macroscopic levels on the base of dynamics, while the correct microscopic description is the description provided by quantum mechanics. On the other hand, Prigogine had built his explanation within statistical mechanics rather than dynamics and included quantum behaviours.

appearance that is unpredictable and non-necessitated; in other words, chance emerges by chance.[235] In fact chance is not something at all. This is the pivot. In chaotic behaviours conditions act as requirements rather than causes; they are unable to necessitate. In fact, such conditions without absolute authority are what define an *open* system. The logic of emergence that acts in such systems will be discussed in Chapter 3, it is important however to keep in mind that this open logic develops the *possible* outside the principle of identity, which instead is at the root of the continuity of sufficient reason.[236]

Deleuze stated that the "present is not the future of a past."[237] In this regard, in Poincaré's resonances unpredictability is not the absence of a ratio or a reason, but the fact that the ratio at work is not reflecting linear commensurability; rather it proceeds in exponential steps.[238] The difference is that such steps break and exceed the definition the system had at initial conditions. Breaking the symmetry of commensurability undoes the link with any ground of identity. As per Gödel's incompleteness, the uncertainty encountered during the evolution of a system corresponds to undecidability and thereby requires an enlargement in the definition of the initial condition or axioms. In other words, sufficient reason becomes meaningless and the continuity between the present and the ultimate required by ontology is interrupted.

Perhaps, in order to pre-empt the association of certainty with predictability, the problem can be turned around: it is the identification of predictability with dynamics that is problematic (this is the message of Prigogine's reconceptualisation). In this model, the linearity of dynamics become overemphasised on the ground of the idealisation of equilibrium states. On the other hand, Prigogine speaks of systems far-from equilibrium, where the flow of energy is key. His proposal is that evaluating metastability and its

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[235] Cf. Alvin Toffler "Foreword", in Prigogine and Stengers, *Order out of Chaos*, XI–XXVI.

[236] Adding to the critique above, d'Espagnat emphasises that the question rising from quantum mechanics is one of "weak objectivity", rather than a problem of indeterminacy; Cf. d'Espagnat, *On Physics and Philosophy,* 320–323. Indeed, his entire reading of the problem seems to adopt a Kantian angle in the definition of the object of knowledge. However, what is at stake with chaotic behaviours is a shift in the notion of cause and not the uncertainty of the object.

[237] Cf. Deleuze, *Difference and Repetition*, 102.

[238] Cf. Prigogine, *The End of Certainty*, 30–46.

possibilities should be incorporated into an alternative model, or rather that it should construct an entirely new unit of measure. In fact, Prigogine's overall suggestion is that the primary units of physics should be the acceleration of resonances, rather than individual descriptions in equilibrium state.

Indeed, Poincaré was right: the approximation in the selection of facts detains all the importance in the definition of identity.[239] An evaluation of metastability can only gain the legitimacy of a unit of measure if, instead of thinking of a point along a causal line, it is turned into a question of *relevance* (mattering). Asking the right question will point towards the relevant answer, yet this will be oriented towards the future rather than *backward* or *downward*, looking at a cause to be preserved. To be precise: inertia exists and cannot be dismissed, and so do the genealogies that in an evolution of relevance should be interpreted as the history of the discourse of inertia. There is, however, a difference to be explored between thinking that the future will be the consequence of a past that was, and *wondering*-questioning about relevance, and asking how this choice of measurement *matters*. The selection of facts, might make the effects diverge wildly from the same conditions, for the evaluation of such conditions cannot be absolute, thus this limit becomes a pattern of possibility. The mechanics of this possibility will be discussed next in Chapter 3.

As will be explained in Chapter 4, the science of complexity shows that it is on the basis of the consequences of resonances that prediction will become meaningful. If it seems self-evident that conditions keep changing, what is equally obvious but has not been heard by ontology is that reduction and idealisation are arbitrary decisions for the sake of the ultimate. Ontology has not received or implemented the encounter with the chaotic behaviours and processes of emergence in its full potential. Rather it has captured these concepts according to its existing categories, and thereby has flattened them into a repetition of the same.

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[239] Poincaré, "The Selection of Facts," in *Science and Method*, 15–24.

In other words, if it is obvious that some events are predictable, as much as anything that falls within the domain of classic mechanics, the problem here is the inverse, both in physics and ontology: it is the installation of *one* form of mechanics (classic or quantum) as the idealised model for all forms of events and for all discourses of knowledge and all practices that is arbitrary. Defences of indeterminacy to protect human freedom do not leave this paradigm; in fact they perpetuate it by upholding the same reductionist logic, and are content with preventing idealisation from completing the reduction.[240] The question concerning the logic of sense must instead be posed outside this image.[241]

Resonances sever the Link between Finitude and Totality - Resonances sever the link between the contingent present of finite created monads and the actualised infinity of God's mind. Compossibility is limited to a local affair; it does not measure its options against the totality of the universe mirrored in the divine gaze.

In "The Monadology," Leibniz identifies perfection with existence: God is absolutely perfect, "perfection is nothing but an amount of positive reality, in the strict sense, setting aside the limits or bounds in things which have them. And where there are no limits, that is, in God, perfection is absolutely infinite." For created monads this logic is reversed: "It follows also that the creatures derive their perfection from the influence of God [the ultimate sufficient reason], but that their imperfections arise from their own nature, which is incapable of existing without limits. For it is in this that they differ from God." Leibniz adds: "God alone (or the necessary being) has this prerogative, that he must exist if he is possible" since it is part of his concept to exist and at the same time there is nothing that

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[240] An example of this position is Popper's argument of indeterminism; Cf. Karl Popper, *The Open Universe,: An Argument for Indeterminism*, ed. W. W. Bartley (London: Routledge, 1988).

[241] Supra: Looking ahead to Chapter 3 and 4, Kauffman will address this reductionism when rejecting an explanation of life as the image of "just particles in motion." This brings a diffused creativity or life, a divine principle, which recalls Spinoza's substance: *Deus sive Natura*, (God as/or Nature) posing a continuity or immanence where Substance folds into its modes. This association should be accepted carefully. The *natura naturans* (as opposed to a created and concluded nature–object, *natura naturata*) for Spinoza and Deleuze does not emphasise enough the turns and the deviations that give rise to folds. The process is not taken into account in its materiality and sensuality, in its constraints. In fact, the process is a not a form of becoming tangent to the pure and eternal virtual Being, it is always historical becoming. Cf. Benedict de Spinoza, *Ethics*, ed. and trans. Edwin Curley (London: Penguin, 1996).

could prevent its existence.[242] It follows that the more existence the more perfection, and God who is absolutely perfect is infinity actualised, while finite monads are limited and thus imperfect; in *The Theodicy* it is made clear that created monads can only be finite and imperfect, since if they were perfect and endowed with infinity they would be a God, running into contradiction for the definition of God implies his infinity and the inclusion of everything and therefore its uniqueness.

The demonstration operated by Prigogine on the basis of non-integrability and impossibility of reduction prevents the passage to the idealisation of such absolute state where the entire totality can be calculated simultaneously and a priori. In this new condition, iterating monads, which function in the complete isolation of their blindness, are cut from the mirroring system of the totality kept in order by God (or which is God). Rather than being located in the totality and measured or qualified against the infinity actualised of God's gaze, their iteration is *constrained* by its own history. The logic of existence and possibility is turned around. As with self-constrained chance, rather than God alone having the prerogative of existence on the base of his possibility, the possibility of existence becomes associated to the finite pattern of existence. Actualised infinity becomes meaningless and *finitude is turned positive*.

In front of diverging trajectories and the laws of chaos that can only be formulated at ensemble level, and of probability in instability versus individual trajectories at equilibrium, the problem of idealization is twofold: the first is "ideological", but there is also a technical one related to the forms of measurement. Calculations are done with fractals, "generalized functions" Prigogine says.[243] "We need a "divine" point of view to retain the idea of determinism. But no human measurement, no theoretical predictions, can give us initial conditions with *infinite precision*" (my italics).[244]

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[242] Cf. Leibniz, §41–45 in "The Monadology," in *Discourse on Metaphysics*, 115–134.
[243] Cf. Prigogine, *The End of Certainty*, 38.
[244] Cf. Ibid., 38.

This is of particular interest with regard to Leibniz and the position Stengers often takes against Leibniz as the champion of the equivalence of causes and effects (the zero sum economy of causality, dynamics, necessity and ultimately making time reversible). Indeed, here idealization is no longer to be grasped as the horizon of quantity (more precision until reaching total precision). There is instead a qualitative jump towards absolute precision. In fact, it is true, that Leibniz presented precisely this differentiation between the "imperfection" of *created monads* locked in time and space and God, the eternal simultaneity of the un-created monad, perfect and complete substance.

Yet, this also supports the thesis' suggestion that Leibniz's God is a weakened figure: nature, science, history happen almost without him. God is only able (after the initial creation) to make the world respect the rules of Grace and Reason, to which he too is submitted: he cannot do otherwise, since he cannot want but the good and the logic. In fact, Leibniz's God does not intervene in the evolution of the universe, there causality is completely preserved, the choice God makes is extra-temporal, metaphysical, it happens uniquely since in God's eternal gaze there is no difference between past and future. That is, the divine point of view that could grasp in one gaze the individual trajectories that compose the ensemble is of a different quality than the logic of science. Idealization is of a different quality from the new logic of science that Prigogine is exposing. Idealisation imagines, dreams, or even imposes, what measurement cannot achieve; this is why dynamics had to so often resort to demons. The shift taking place here is a truly empirical one in the sense that scientific practice (in this case mathematics) is no longer a transparent vehicle, but has a fundamental impact on the image of the universe and the notion of truth (which Stengers has called "the truth if the relative.") What is important for the interpretation of Leibniz here is that it begins to become evident how it is possible to sever the link creator-created monads in his universe. Indeed, Leibniz's system works perfectly well even if the moment of creation is forgotten; once the universe is in motion it no longer needs the control of God, unlike in Newton's interpretation. It becomes possible to also sever the link between the questions *why something rather than nothing* and *why thus rather than otherwise*. The first

ontological question can be abandoned for in a finite present only the second aesthetico-epistemological question has relevance. Prigogine had concluded that even Laplace's demon "can no longer predict the future unless he knows the initial conditions with infinite precision."[245] Infinite precision becomes a metaphysical pre-condition that science can no longer take into account.

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[245] Cf. Prigogine, *The End of Certainty*, 38.

Chapter 3: The Mechanics of the Possible

3.1 Abdication and Withdrawal

Given the demise of identity and determinism seen in Chapter 2, how is possibility still possible, rather than vanishing in a sea of chaos and arbitrariness? To understand the importance of this question it is necessary to look deeper in the condition of *fragility* that Stengers has ascribed to physics following the reconceptualisation of dynamics formulated by Prigogine.[1] Chapter 2 has shown how by addressing a problem internal to science (the incompatibility of dynamics and thermodynamics) Prigogine reached a reconceptualisation alternative to the canonical representation of reality, which raises issues for both the image of matter and the homogeneous image science projects of itself. Isabelle Stengers emphasizes how the reconceptualization of dynamics that Prigogine had accomplished is actually an epistemological shift;[2] however, this shift is not between paradigms but in the notion of paradigm itself and, therefore, becomes an ontological problem, or better a *counter-actualisation* that forces science to *abdicate* and to *withdraw* the universal claims it attaches to its objects. As will be seen this fragility goes as far as to affect the continuity postulated by ontology's transition to the ultimate. In other words, as certainty is the epistemological expression of the absolute, fragility is the epistemological expression of incompleteness, the irreducibility of descriptions formulated inside the practice of science.

Not a new universality - This fragile condition science finds itself in results from a loss of *absolute legitimacy* of scientific claims. The demonstration of non-integrability operated by Prigogine and Stengers does not introduce a new truth. They have been very clear on this point: irreversibility does not constitute *a new universal*; irreducibility must not

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[1] Cf. Chapter 2 in the thesis. For the claim about *fragility* Cf. Isabelle Stengers, *Cosmopolitics*, Vol.1, trans. Robert Bononno (Minneapolis, MN: University of Minnesota Press, 2010), 4.

[2] This is the tenet of *Cosmopolitics'* Book 5 "In the Name of the Arrow of Time: Prigogine's Challenge," where Stengers examines and develops the consequences of Prigogine's work within her project of re-elaborating the notion of *coherence* between science and other practices. Stengers will go on to articulate how the fact that this shift has not been received from the scientific community is not due to a weakness of the theory put forward, but is the very ontological kernel of the problem. Cf. *Cosmopolitics* Vol.2, 105-204.

be grasped as a "fundamental truth regarding the real."[3] The heterogeneity of chaotic behaviours cannot be unified into one ontological continuity.[4] The universe is instead *plural*: (some regions of the universe are in fact reversible and symmetric, while most are not).[5] Finitude results from a demonstration of impossibility where the image of science is undone without being rebuilt in any new solid way (the fragility indicated by Stengers). The pivot is that the demonstration is put forward from inside dynamics, not from a third Archimedean point external and neutral. This leads physics to abdicate and to withdraw all absolute claims. Ontology –as will be shown- is also affected by this limit. In fact, what takes place is a *counter-actualisation* of the installed logic that forbids both forms of ontological ultimate (the reduction to axioms or ground and the passage to the limit). The heterogeneity and locality of chaotic behaviours become foundational limits, positive constraints; that is, genetic *dimensions* of the finite present.

Already in *Order out of Chaos* Prigogine and Stengers had emphasized that the unmaking of linear dynamics as the model for physics is not equivalent to introducing a new universal theory.[6] In fact, -they went on to claim- "there is no longer any universally valid law from which the overall behaviour of the system can be deduced. Each system is a separated case."[7] This exposed how the limits of finitude subtract the ground and leave the boundary open, rather than putting forth a new law that is universally valid. In fact, the processes of emergence cannot be thought without the openness of the temporal horizon of

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[3] Cf. respectively Ilya Prigogine and Isabelle Stengers *Order out of Chaos; Man's New Dialogue with Nature*, (London: Harper-Collins, 1984), 285; and Ilya Prigogine and Isabelle Stengers, *Tra il Tempo e L'Eternità*, trans. Carlo Tatasciore (Torino: Bollati Boringhieri, 2014), 139.

[4] Prigogine stated, "The fact that there are bifurcations everywhere does not constitute a continuity". Cf. 22nd *Solvay Conference* held in Delphi, Greece, November 24-29, 2001. Last modified April 29, 2011, accessed on June 6, 2016, https://www.youtube.com/watch?v=MnD0IIBvgO4.

[5] Cf. Prigogine and Stengers, *Order out of Chaos*, 257.

[6] The non-universality of irreducibility holds a fundamental place in Prigogine and Stengers work. This claim is repeated in several passages of *Order Out of Chaos*: Cf. "irreversibility, it has been repeatedly stated, is not a universal property," 251; or "the world is pluralistic," 257. This notion is developed in the last chapter "Irreversibility, the Entropy Barrier," 257-290; and explained in full in the conclusions "From Earth to Heaven - The Reenchantment of Nature," 291-313.

[7] Cf. Prigogine and Stengers, *Order out of Chaos,* 144-145. The loss of universality constitutes the severance with the modern paradigm of thought. Note the three key concepts that upturn ontology: *universality*, *law* and *deduction*, which involve identity as well as the notion of 'concept' in the collapse.

chaotic behaviours and their heterogeneous locality. As will be seen, this fragility must not be grasped as weakness, rather as the property of systems whose openness is the condition for their development.[8]

Before proceeding with the investigation of possibility outside the space organised by a reduction to the ultimate, it is important to articulate how this counter-actualisation takes place, because the reasons leading to it are both multiple and relevant on different fronts, but all converging on the concept of finitude of the present. As seen in Chapter 2, the proof of non-integrability is produced inside physics, yet this has radical repercussions outside science at epistemological and ontological level. In turn, this shows how the thesis can build on the notion of irreducibility without the risk of falling into an empiricist objectivity that would adopt physics as the source of a new truth and entrust science with the ultimate authority of providing a proof for thought. In parallel, this counter-actualisation constitutes an opening that is key to the formulation of the *constructive* notion of truth that is at the core of Stengers' notion of scientific practice: a practice intrinsically *genetic*, inspired by the speculative interpretation of concepts introduced by Deleuze;[9] thereby shifting the question onto an ontological level. Lastly and most importantly, the notion of counter-actualisation is essential in supporting the thesis' interpretation of the *constraints* that shape a practice as intrinsically creative, and -as will be seen- acting as the genetic dimensions in a regime of finitude; thus leading to a logic of dimensionality rather than the ontological ultimate. In fact, idealisation and symmetric reducibility, both intrinsic to the logic of the ultimate, are antithetic to art. A logic based on the ultimate abstracts the present into a pure form, of which every contingent instance is only a representation; a copy, at the same time not

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[8] William Connolly develops an analysis of the political risks involved in this fragility, in the more traditional questions of capture of emerging and produced values by capital. Cf. William E. Connolly, *The Fragility of Things: Self-Organizing Processes, Neoliberal Fantasies, and Democratic Activism*, (Durham, NC: Duke University Press, 2013).

[9] Cf. Gilles Deleuze, "The Image of Thought," *Difference and Repetition*, trans Paul Patton (London: Continuum, 2008), 164-213.

autonomous and dispensable.[10] That is, all contingent instances, whether phenomena or artworks, are expressions of *the Same.* Therefore if they could attain perfection they would express or represent perfectly their model. However, since this model is the Same, they would all represent the same thing in the same way. No distinction among artworks or artists could exist (absolute identity and absolute boredom). This is not the dictatorship of the canon but a more fundamental one imposed by the *syntax* of idealisation; it is the inevitable logic implicit in the regime of idealisation that structures ontology.[11] On the other hand, as will be seen, it is precisely the intrinsic impossibility to reach or think such perfection that provides the genetic pattern of the logic of sense. As Poincaré had indicated (see Chapter 2) the intrinsic impossibility of an absolute (or infinitely precise) definition of the world introduces finite and patterned expressions, which are what makes art interesting and sense worth engaging with.

Then one should ask, what did Prigogine and Stengers actually demonstrate if their results do not constitute a new universal truth. Initially, their claim had played within the traditional paradigm of positive science, announcing the discovery of a new theory that, if it did not want to claim the status of a new universal law, was nevertheless a new conceptualization that aspired to replace the image that physics, modelled on the integrability of dynamics, presented of itself and of nature. Indeed, the possibility shown by Prigogine of another platform for conceptualising physics introduces an irremediable fissure in the accepted homogeneity of the claims of science (what Stengers describes as the non-equivalence of image and "laws of physics" with the image and "laws of nature").[12] However, this proof is a peculiar kind of proof. In fact, it is just the proof of the existence of an alternative, a *there exists at least one instance* ('∃' in formal language) where dynamics

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[10] Derrida gives a very clear account of this problem at the root of the paradigm of representation. Cf. Jacques Derrida, "Plato's Pharmacy," in *The Dissemination*, ed. and trans. Barbara Johnson (London: Athlone Press, 1981), 61-119.

[11] Thereby, falling short of perfection (the pure intelligibility of idealisation) art would be art negatively, just because it is obscure and confused and would struggle in vain for the clarity of the intellect. Creativity and originality would be doomed to lesser events.

[12] Stengers, *Cosmopolitics,* Vol.2, 201.

is not integrable, and therefore not reversible and not representational. It is this proof of existence, or proof of possibility where the symmetry of dynamics' reversible processes is shown as a special case in an asymmetrical and irreversible universe, that has left physics in the *fragile* state that Stengers points out. The image of physics and the image of nature that physics presents are not absolute, but both are potentially multiple and always constructed.[13] Other images able to impose their "own terms" would be equally valid yet, not *equivalent* to it.[14] The demonstration that there exists at least one instance where the universal statement is not the case is enough to counter-actualize the integration of ontology. It is important to point out how this is not an external limit, but a positive affirmation generated inside the system. However, this presence cannot be pronounced *absolutely*.[15]

In fact, what is relevant in Prigogine's work is a demonstration in a way more modest than the heroic claims about the universe being *thus*. Prigogine simply shows that *something else is also possible*; or that the current order is not absolute. The claim is gentle, not universal and yet it constitutes a counter-actualization not only of the existing claim of truth, but of the very possibility of claiming absolute truth. In fact, it constitutes a counter-actualization of the absolute universality of any claim of truth about a fact, in favour

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[13] Stengers, *Cosmopolitics*, Vol.1, 38-39. How this construction is not a solipsistic projection, but a coherent logic is the focus of the entire first Book of *Cosmopolitics*; Cf. Stengers, "The Science Wars," in *Cosmopolitics*, Vol.1. 1-83.

[14] The problem of an event of measuring able to impose its own terms and therefore able to radically alter the accepted image of reality is one of the fundamental concepts proposed in the Cosmopolitical project, for what concerns this non-equivalence in Prigogine's reconceptualisation of dynamics, Cf. Book V, "In The Name of the Arrow of Time: Prigogine's Challenge," in *Cosmopolitics*, Vol.2, 105-204.

[15] Counter-actualisation is concept at the centre of Stengers interpretation of Prigogine's research. As demonstration of the possibility of existence of another model or image for thought Stengers refers directly to Deleuze and Deleuze and Guattari, in particular to the figure, or "psycho-social type" of the "idiot" (Dostoyevsky's *Idiot*) and his move to counter-effectuate the order of things; Cf. Isabelle Stengers, "Deleuze and Guattari's Last Enigmatic Message," *Angelaki* 10 no. 2 (2005): 151-167; and Deleuze's analysis of Melville's character *Bartelby*; Cf. Gilles Deleuze, "Bartelby, Or The Formula," in *Essays Critical and Clinical*, trans. Daniel W. Smith and Michael A. Greco (London: Verso, 1998), 68-90. For the concept of actualisation and counter-actualisation at the centre of Deleuze's thought, Cf. Gilles Deleuze, "Twenty-First Series of the Event," in *The Logic of Sense*, ed. Constantin V. Boundas, trans. Mark Lester and Charles Stivale (London: continuum, 2004), 169-175.

of the factish built on what Stengers calls a physico-mathematical fiction.[16] A strictly scientific problem of compatibility between two theories (dynamics and thermodynamics) has exploded, shattering the boundaries of science and the frame of epistemology, to impose itself as an ontological problem. Absolute claims are impossible, only finite configurations are admissible. The present is finite. Ontology is finite. Possibilities may be infinite, but they cannot be unified in a continuity that would create a new horizon or ground; all configurations are local and heterogeneous, no absolute is possible.

It must also be emphasised that the impossibility to integrate that leads to irreducibility is not obtained through a *reductio ad absurdum*, which would still imply the knowledge of an a priori totality where all options but one are barred. Rather it is a proof of incompleteness. It is a demonstration that undoes certainty, rather than proving a new certainty.[17] As was seen in Chapter 2, this shares similarities with the proof of incompleteness presented by Gödel. However, the difference, as will be seen, is that Isabelle Stengers is able to show that such finitude is intrinsically creative; it is the pattern upon which sense is possible. In turn, this will be the key for explaining the notion of dimensionality as primarily aesthetic and yet non-representational.

It is particularly important to grasp the importance of the source of the impossibility demonstrated by Prigogine. It is by proving non-integrability from inside dynamics, rather than bringing a new counter-factual proof from a position external to the discourse it is acting upon, that Prigogine induces a counter-actualisation of the very discourse of dynamics. That is, the very fact that different mathematical models can lead to different images of matter has a radical impact on the image of unity of nature that physics projects, as well as the homogeneous and continuous image that science projects of itself. This is enough to expose that physics is not as an absolute language that speaks on behalf of the

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[16] Cf. Stengers, "The Laws of Chaos?" in *Cosmopolitics, Vol.2*, 160-175.

[17] Supra: It will be seen in Chapter 4 how this point is crucial for debunking Meillassoux's alleged demonstration of a new metaphysical absolute.

real, but rather a generator of platforms with different potentials and different consequences.

Finitude is thereby stated twice. Yet, this double move is not a double cause rather it is somewhat passive: incompleteness is the impossibility of totalisation, not an external limit. One argument concerns the object of science, the non-integrability of dynamic systems, and it is internal to physics. The second, instead, concerns physics as a discourse and as an ontological model, and has an effect on the image that science presents to the rest of the world, to the other discourses, of linear rationality as logic of sense. It is on the basis of this second argument that Stengers can build her interpretation of the fact of science as a *constructivist* event (or factish) that sees the object of science and the theory that describes it emerging simultaneously in a "reciprocal capture."[18] However, this second onto-epistemological argument would not have been possible without the withdrawal imposed onto physics' universal claims by the possibility opened by the different mathematical representation developed by Prigogine.

The reductionist paradigm is thus under a double line of attack that prevents any form of ontological continuity (reduction towards the ultimate, or totalisation), which -it is important to remember- includes in its logic both reduction to the ground or axioms and the passage to the limit or difference. Finitude has a double fold: the possibility of a local plurality exposes the impossibility of a total unity; or affirming the *non-universality of the proof* within physics exposes the *counter-actualisation* of epistemology and ontology. On the one hand it prevents the image of an absolute object of knowledge or thought from reaching a conclusion or being totalised; on the other, it does not allow language to claim any form of absolute representation of such an object. This is an issue broader than the

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[18] "Reciprocal Capture" is one of the key concepts that articulate Isabelle Stengers's notion of practice; Cf. Stengers, "Constraints" in *Cosmopolitics,* Vol.1, 42-55; and also *Cosmopolitics*, Vol.2, 196. While such mutual capture for Stengers stems primarily from the convergence of heterogeneous vectors in a rhizomatic assemblage, there is also an obvious echo of the "event of appropriation" that for Heidegger constitutes the emergence of presence, the extension of the horizon of the given. Cf. Martin Heidegger, "The Principle of Identity," in *Identity and Difference*, trans. Joan Stambaugh (Chicago, IL: The University of Chicago Press, 2002), 23-41.

simple materiality of the practice of the language of representation, be it verbal communication, mathematical representation, experimental practice, or visual reproduction. The possibility of different models of representation in fact destroys the very notion of language (including mathematical language) as a neutral *communication* vehicle and shows to be thick and opaque, intrinsically *genetic*; a creative practice (aesthetic-artistic) rather than a *medium* ferrying meaning between the two banks of ontology (the contingent present and the necessary ultimate).

It is necessary to pause here and listen to what this fragility implies for the image of science and its relation to ontology. Prigogine and Stengers describe how the heterogeneity and locality of chaotic behaviours imposes that physics abstain from what they call claims of "extraterritoriality."[19] This cannot be overemphasised. Prigogine's new proposal is a demonstration that does not *impose itself but exposes* a radical openness of physics and thought when concerning ontology.[20] Yet, this is not to be taken as a vulnerability; and certainly not as a subjective weakness of an ontological nature (the weak hermeneutics of approximation.) Rather, as will be seen, it must be grasped as *metastability* or metastable equilibrium: a form of *transcendental*, whereby the system is open and its boundaries out of focus and flexible, fluid.[21] In other words, fragility means that physics is forced to withdraw the claims that capture all territories of knowledge and practices of sense as deducible from dynamics; as Prigogine and Stengers point out, it shatters the notion of physics as the model science.[22] This amounts to an *abdication*. Yet, this is not an impossibility of

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[19] "We believe that the epoch of certainties and absolute oppositions is over. Physicists have no privilege whatsoever to any kinds of extraterritoriality." Cf. Prigogine and Stengers, *Order out of Chaos*, 299.

[20] Stengers comments that the scientific community has remained indifferent to Prigogine's proposal. The incorporation of probability in the fundamental description of dynamics, Stengers says, can be welcomed only among "friends" who would already be disposed to listen. Cf. Stengers, *Cosmopolitics*, Vol.2, 116-119.

[21] Metastable equilibrium is the logic of coherence of the dissipative structures that Prigogine had studied in thermodynamics, assemblages without a priori identity and lasting as long as an external flow of energy permits their internal processes to repeat. Cf. Grégoire Nicolis and Ilya Prigogine, *Exploring Complexity; an Introduction*, (New York, NY: Freeman and Company, 1998); and Prigogine and Stengers, "The Science of Complexity," in *Order Out of Chaos*, 103-209.

[22] Cf. Prigogine and Stengers, *Tra il Tempo e l"Eternità*, 62-64. This non-deducibilty of macroscopic sciences from Physics emphasised by Kauffman's work on the notion of emergence in biology, in fact the answer he proposes constitutes, as will be seen later in the chapter, a critical key for the formulation of possibility without

knowledge, rather this abdication concerns the *domain of validity* of physics and of each specific theory; it concerns the claim of totality that supplies a scientific support for idealisation of ontology. Looking for a moment towards the thesis' conclusions, it is possible to say that identity is metastable.

One of the arguments that animates Stengers' *Cosmopolitics* is that physics is projected as the foundation for all sciences, thereby implying a linear reducibility and demanding that the practice of other sciences does not contradict physics.[23] There is a parallel between this reduction of science to physics and identifying philosophy primarily with ontology. Yet, this is not a simple analogy. In fact, complexity brings a radical challenge to ontology (to be precise, it demands a renegotiation of those critiques that already hoped to overcome a priori identity, as those moved by Heidegger and Deleuze, with particular emphasis on the re-interpretation the latter makes of sufficient reason.)[24] This challenge, however, is not an active attack to ontology's presuppositions; it does not aim at replacing the existing paradigm, rather it is a *withdrawal*: physics pulls back, denies its participation; it is no longer the accomplice of ontology's essentialist logic of reduction or idealisation (the logic of the ultimate).

With non-integrability ontology becomes twice orphaned: first, with regard to a smooth reduction of all events to fundamental elements of matter (or axioms in logic); then, it is deprived of physics as its twin discourse of reduction. There, where ontology expects a confirmation or a partner for the reduction to the ultimate, physics is no longer available for support. By undermining the privileged relationship between physics and ontology, the fragility of science becomes also the *fragility of ontology*. With Prigogine's alternative

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reduction to the ultimate. Cf. Stuart A. Kauffman, "The Nonreducibility of Biology to Physics," in *Reinventing the Sacred: A New View of Science, Reason, and Religion* (New York: Basic Books, 2010), 31-43.

[23] As it was shown in Chapter 2, this was also at the root of the problem of idealisation that Prigogine had individuated between dynamics and thermodynamics; at the same time, this reflects the notion of consistency that had provided a paradigm and a requirement for logic until Gödel disproved its universality.

[24] Cf. Heidegger, *Identity and Difference*; and Martin Heidegger, "The Question Concerning Technology," and "The Age of the World Picture," in *The Question Concerning Technology and Other Essays*, ed. and trans. William Lovitt (New York, NY: Harper, 1977), 3-35, 115-154. Cf. also Deleuze, "Difference in Itself" and "The Image of Thought" in *Difference and Repetition,* 36-89 and 164-213.

possibility, physics de-territorialises the terrain that the ontological paradigm of consistency and commensurability had laid out for it and this withdrawal of physics leaves ontology exposed to the irreducibility of the present. Finitude cannot be empirical without being at the same time onto-epistemological. That is, there cannot be a finite object if the discourse, concept, language that describes it is still absolute.

One is allowed to wonder if the reductionism of the ontological interpretation is an intrinsic affliction of philosophy, as the onto-theo-logical barrier that Heidegger encountered on his path and feared could never be overcome. However, it does not have to be. Not all questions need posing primarily in ontological terms, nor must all events of sense be reducible primarily to Being or identity.[25] In fact, the stake here is precisely overcoming the paradoxes of the groundless without reverting to the absolute. Prigogine had been very clear on this: non-integrability and emergence constitutes "a return to realism [away from idealisation] but emphatically not a return to determinism.[26] The impossibility to universalise constitutes a shift away from the paradigm of foundations, or onto-theological image of sense. The onto-theo-logical barrier that Heidegger had found, which prevented breaking away from metaphysics, may find here one of its most powerful challenges.

Interestingly, Bruno Latour introducing Isabelle Stengers' work emphasises that Stengers' focus is ontology, rather than remaining within the limits of philosophy of science.[27] It is, however, a peculiar way into ontology because it stems from the limit encountered by physics in picturing the world according to one homogeneous

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[25] In fact Heidegger is perhaps one of the champions of such ontological reductionism, since each question he raises leads straight to redressing the relationship with Being. For the notion of onto-theo-logical, Cf. Heidegger, "The Onto-the-logical Constitution of Metaphysics," in Identity and Difference, 42-74.

[26] Cf. Prigogine, *The End of Certainty*, 131.

[27] Cf. Bruno Latour, "Foreword," in Isabelle Stengers, *Power and Inventions; Situating Science*, trans. Paul Bains (Minneapolis, MN: University of Minnesota Press, 1997. It must be pointed out that the ontology Stengers follows is inspired by Deleuze's concept of problematic and genetic ideas introduced in "The Image of Thought," *Difference and Repetition*, 164-213. On this trace Stengers develops an interpretation of the notion of science as an *event*; a *generative* and *creative* practice operating beyond the representational logic of the universal. As it was mentioned in Chapter 2, in Deleuze's ontology there remains, like in all deleuzean lines of research, a metaphysic of sufficient reason divested of identity and conflated on a pure form of possibility that does not entirely rid sense of a reductionist logic; difference occupies the ultimate place that until recently had belonged to Being.

image/paradigm. This impossibility internal to physics and its mathematical models has an impact on representation in general. Whether it is predominant or an exception, the asymmetry discovered by Prigogine interrupts the ontological continuity that belongs to the paradigm of foundations, which –it can never be overemphasised- comprises both the positive image of ground and its negative or frustrated abyssal interpretation.

If the work of Prigogine thwarts any aspiration of reduction to the ultimate because it withdraws the support from the claim of universalisation or idealization, how is it possible to declare the reduction to the ultimate illegitimate without entering a contradiction where complexity is interpreted as yet another scientific theory that provides a model or a ground for the logic of sense? That is, without denying the absolute on the ground of a new absolute. The answer is in the notion of withdrawal that complexity imposes to physics. What is relevant in Prigogine's work is *not what science does*, but *what it can no longer do*. That is, the interruption of the homogeneity that philosophy expected science to have when questioning nature. An expectation of homogeneity that science was very glad to adopt as one of its epistemological dimensions, or perhaps even as the ground on which to establish its authority for the disqualification of other practices, of other questions, as non-scientific.[28] The relevance of Prigogine's work in this regard is not solely the choice to listen to the counter-instances emerging from the experimental practice, without attempting to smooth them down with approximations, so that they would fit the reductionist theory; rather, or in addition to this, the relevance is that alternative mathematical models can be produced that are apt to include and explain such counter-instances, but most importantly without being opposition to the existing paradigm. As will be seen, this is where Thomas Kuhn's notion of *shift* can no longer offer any help. The reconceptualization that Prigogine proposes is not a simple shift from paradigm A to paradigm B. Rightly, Prigogine calls it an "enlargement" of physics able to contain previous theories as a *special case* of the new description.

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[28] In Isabelle Stengers's distinction, rather than simply excluding myth and sophism as its other, modern science is the one that raises one method, one measurement, to the status of rationality, excluding all the others as subjective opinion; science is therefore intrinsically political. Cf. Stengers, "Scientific Passions," in *Cosmopolitics*, Vol.1, 1-13.

A different shift has taken place here. Physics has abdicated. It has withdrawn its claims of "extra-territoriality" that demand that its fundamental laws are satisfied at all levels of magnification and complexity as well as by all other laws.[29] Physics can no longer act as the axiom of which other sciences would be theorems. In other words, what Prigogine manages to do neither imposes a new claim as universal, nor induces a plain abdication that would allow a relativism (the weakness of opinion) to take over. Rather, as Stengers shows, it is the demonstration that a logic exists, for without a logic there would be no coherence and yet it is no longer possible to claim the universality or the homogeneity of such logic.[30] The laws of chaos, Prigogine repeats, emerge heterogeneously and locally.[31] As will be seen later in the chapter, this is the problem of the *necessary* but not *sufficient* conditions that permit chaotic behaviours to emerge.

What has been destroyed, by the heterogeneity of the laws of chaos, is precisely the notion of the ultimate as the root of ontology, or correlatively the notion of the *surface* as something that lacks the legitimacy for supporting itself, its reasons and its relevance; that is, aesthetic contingency. No other problem had yet hit representation so close to its roots. The Heideggerian groundless, Gödel's undecidability, or the interpretation of chaos as ontological difference put forth by Deleuze and Guattari all stopped short of removing the ultimate. At best, they take place inside the space opened by the event of the ultimate even if this is not longer complete or total; that is, they take place in the wake of its disappearance.[32] They function inside the event of linearity as its negative frustrated

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[29] Cf. Prigogine and Stengers, *Order out of Chaos*, 299.

[30] This is the fundamental tenet of Stengers' re-elaboration of the notion of coherence following Prigogine's work. Cf. Stengers, "In the Name of the Arrow of Time: Prigogine's Challenge," *Cosmopolitics*, Vol.2, 105-204. Also for Stengers' claim Cf. "Scientific Passions," *Cosmopolitics*, Vol.1, 1-13.

[31] Prigogine insists that chance cannot be interpreted as a replacement of causality, a faceless cause, or a deleuzean quasi-cause, because it is impossible to predict when it will present itself and cause further bifurcations and divergences. Cf. Alvin Toffler, "Foreword: science and Change," in Prigogine and Stengers, *Order out of Chaos,* XI-XXVI. More emphasis on the causal role of chance is found in Monod interpretation. Cf. Jacques Monod, *Chance and Necessity; An Essay on the Natural Philosophy of Modern Biology*, trans. Austryn Wainhouse (London: Collins, 1972). Monod, however, makes chance into something separate and potentially opposite to order, which –it will be seen- is not the case with complexity.

[32] In *What is Philosophy* Deleuze and Guattari make direct reference to Prigogine and Stengers *Tra il Tempo e l'Eternità* for their concept of the limit condition or pure difference, thereby adopting the chaotic state where

attempt (the mourning of the crisis of foundations.) From the transcendental to the incomplete, a negative definition taints ontology. As will be seen, with complexity this very notion will undergo a radical reinterpretation as metastable, abandoning a priori expectations of unity for a temporal and ephemeral identity of open systems which shed all negativity.

The work of Prigogine and Stengers is instead particularly refreshing. They move in an alternative direction to this linearity. Their *withdrawal* does not leave the same structure in place, a vacant throne waiting to be occupied by a *regent* in the absence of the monarch. A regency ontology would only bring upon complexity the restoration proposed by the Speculative Realists (indeed, one should actually wonder why this reaction did not take place sooner).[33] Rather, the withdrawal of dynamics leaves behind a terrain that is not smooth, or in need of a new ruler, but a *decolonized* territory,[34] which in this case is not simply a de-territorialized territory as Deleuze and Guattari would understand it, but is marked, striated, patterned with the history of development of ideas and technologies, of shifts and changes   (as will be seen in Chapter 4 these can be articulated as

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repetition periods are infinite and nothing ever returns, as a scientific counterpart for their ontological image. However, there is a circularity that should be highlighted here, Isabelle Stengers had already adopted the deleuzean notion of event as a conceptual key for the organization of *Tra il Tempo e l'Eternità* and also in *The Invention of Modern Science* and in *Power and Inventions*. In turn, the interpretation of chaos put forth by Deleuze and Guattari in *What is Philosophy* is again adopted by Isabelle Stengers in *Cosmopolitics*. Cf. Gilles Deleuze and Felix Guattari, "Functive Concepts" and "From Chaos to the Brain," in *What Is Philosophy*, trans. Graham Burchell and Hugh Tomlison (London: Verso, 2011), 117-134 and 201-218.

[33] In fact, the notion of active matter that Prigogine and Stengers propose instead of the inert matter of linear mechanics has already been reinterpreted as autonomous and not in need of human participation. See for instance the notion of *vibrant matter* proposed by Jane Bennet, or the neutrino as *ancestral object* in Meillassoux and Harmann. Cf. Jane Bennet, *Vibrant Matter: a Political Ecology of Things*, (Durham: Duke University Press, 2010); Quentin Meillassoux, *After Finitude, an Essay on the Necessity of Contingency*, trans. Ray Brassier (London: Continuum, 2009); and Graham Harman, *The Quadruple Object* (Winchester: Zero Books, 2011).

[34] Isabelle Stengers writes of a colonization of practices by the practice of idealisation, or ontology, as that which organises and sets a hierarchy both arbitrarily and in its own favour; the same illegitimacy of the idealisation in linear dynamics. Cf. Isabelle Stengers "Wandering About Materialism," in Levi Bryant, Graham Harman, and Nick Srnicek eds. *The Speculative Turn, Continental Materialism and Realism*, (Melbourne: re.press, 2011), 368-380. For the notion of smooth terrain and space Cf. Gilles Deleuze and Felix Guattari, "1440, The Smooth and the Striated," in *A Thousand Plateaus: Capitalism and Schizophrenia,* trans. Brian Massumi, (Minneapolis: University of Minneapolis Press, 2005), 474-500.

genealogies.)[35] That is, the withdrawal from the claims of homogeneity and universality, and censorship this imposed via approximation, leaves behind a *roughness* whose pattern is the genetic potential of the present. No metaphysical possible is needed for it to operate with sense and produce coherence, no quasi-metaphysical virtual can replace it or provide the guide for it; its present materiality is sufficient. However, as will be seen, this materiality is made of genealogies rather than simply objects with tangible mass. And, as has been seen, the recursive interpolations discussed by Mandelbrot adopt history as their material and, for the purpose of art, as their subject matter too. Matter and discourses can no longer be distinguished because in the logic of complex behaviours one is the body of the other, or this distinction disappears altogether. To be clear, aesthetics is not confused with ontology on this rough terrain left behind by the withdrawal of claims of universality (of physics or ontology).   Rather, patterns and the genealogies no longer colonised (or enframed) constitute an *all that there is* without any possibility of thinking of either its opposite (all that is not) or its ultimate (whether essence or facticity). History is Being -if this concept has to be retained- and therefore it is both the body and the dimension on which making sense (art or logic) can act. This points to a logic of coherence open and historical. That is, it demands to renegotiate the logic of the rhizome in the light of complexity in order to provide a new concept of possibility.

The counter-actualisation is a fundamental concept here because it is the hinge on which the reconceptualisation of aesthetics proposed in the thesis is both possible and original. If one stays with the notion of demonstration (as those put forth by Poincaré, Mandelbrot or indeed Prigogine) to prove that the present is finite, one poses a new truth about a determined object of knowledge. The absolute is not dispelled and there will always be a move approximating towards it (and the truth claims concerning it). There will always be a contingent moment and an ultimate (ground or limit). Aesthetics will remain superficial and ephemeral, transient and disposable. Instead, if the counter-actualisation involves the

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[35] As will be seen in Chapter 4, this concept relates to Nietzsche and Foucault.

very notion of truth, or absolute object, replacing it with a *constructive* logic of sense (as a topology or local heterogeneity); that is, if the representation of a hard objective reality is replaced by a factish capable of imposing its own reasons as the truth of the relative (as Stengers says), then it is possible to see that the *problematic is genetic*. In other words, it becomes evident that the problematic presence just ascribed as the truth of the relative, and the practice that installs it, is genetic in so far as it *creates presence*, already endowed with sense; always already endowed with sense at local level of *thus* rather than *otherwise*, rather than that of the pure ontological level of why *something* versus *nothing*, and it would not be able to do otherwise with some sort of pure presence.

It is the counter-actualisation that reveals the extent and the shift introduced by Prigogine's demonstration of impossibility, rather than posing a new truth. Only on the basis of the incompleteness that this exposes, is it possible to have real genetic/creative practices (making sense, rather than representing a priori identity). Deleuze exposes recognition as the even economy of a priori causality within a concluded perimeter defined by identity. Incompleteness instead permits change/creativity. Yet, this is not enough. Openness is related to possibility in different terms than the ontological possible (or virtual) that Stengers borrows from Deleuze. Openness is finitude without boundary. It has conditions (as Stengers puts it, replacing concepts of identity), but without any sort of existence when not actual (thus turning against Deleuze, who sees the virtual as real but just not actual).[36]

The *scientist* claims that irreversibility is a problem generated at macroscopic level by an observer with limited capabilities who is therefore forced to approximate, while idealization permits to think or recognize reversibility as deep truth. The *epistemologist* individuates idealization as the problem behind reversibility and reducibility. The *philosopher* instead should ask why idealization seems so inevitable; why the reduction to the ultimate (Being or limit) constantly returns as the broadest structure that enframes thought. This is as an image of thought ingrained to such a degree that it cannot be

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[36] Cf. Prigogine and Stengers, *Tra il Tempo e l'Eternità*, 62-64.

escaped when asking philosophical questions. All points to the fact that the real onto-theological syntax as the dimension of thought decried by Heidegger is still with us.

Indeed, when philosophy looks at the findings of physics for reference or inspiration, it is actually blindly entering a circularity. This is not a matter of seeking proof where none can be found, for it is obvious that philosophy cannot seek proof in science without resigning to an empirical materialism, thereby also resigning all autonomy and control to science. The problem is more insidious and far more dangerous. In fact by referring to physics in such a manner, philosophy is still referring to the image of fundamentals; it is still applying, that is, a model of reducibility which either looks at the fundamentals of matter as parallel to the axioms of logic, or looks at the transition to the *limit* as the seeking of an essence, which would be revealed in the projection to infinity, so that the system, the universe or the logic, would reveal its *real* and *essential* truth. This reductionism is equivalent to a *full picture* visible only when *stepping back*, that only the actualized totality of the projection to infinity/limit can offer. Negative definitions of ontology, from groundless ground to incompleteness and indeed difference, do not escape this spatialised image; rather they operate in its absence or wake. The alternative that complexity offers, and which is only partially heard, is not a new truth, the introduction of new fundamentals or of a new form of transition to the limit. Rather it is the prohibition of this very possibility; the prohibition of the reduction of the present to any form of ultimate common denominator (Being or Difference) and the demonstration instead of the impossibility of any dematerialised or disembodied gaze (ontological), not only for physics but for philosophy as well.

It is *dynamics* that had to declare that its discoveries and practice can no longer be expanded to reach all forms of contingent and historical existence (the psycho-chemical or socio-economical organizations for instance). It is physics that is forced to declare its inability to offer a continuous explanation from microscopic to macroscopic states, which can be based on the microscopic; as was shown in Chapter 2, this impossibility of deduction is the same as Gödel's incompleteness. Finally, it is physics that –by

withdrawing- tells philosophy that philosophy has misused it or at least misinterpreted it; that it can no longer act as its example or axiom; and that the continuity between dynamics and the logic of sense has been interrupted. Physics, that is, is not imposing a new truth replacing the existing one, rather it remains *silent* precisely there where it used to speak the loudest. The dialogue between ontology and science must therefore be restructured.

This is a shift of such magnitude that its shock has not yet been clearly felt. It introduces a radical incommensurability that, instead of the colonization by reductionist or essentialist logic, will require *ecologies* and *democracy* rather than ontology, as Stengers proposes in her *Cosmopolitical* project. However, interpreting this new logic of coherence via the assimilation of chaos and complexity to ontological difference or virtual is precisely this misunderstanding, this deafness, dictated by the rush to foreclose the new problem with the dimensions of the existing paradigm (or imposing onto a new problem an old and recycled answer). This is where Stengers exhorts us to "stay with the problem," rather than hastily foreclose it. The task of a *slow philosophy* is precisely to learn how to move-think-act-orient in an incommensurable territory and universe.

Shifting the Notion of Paradigm - It would be reductive or altogether misleading to present the story of Prigogine's reconceptualization simply as a paradigm shift, for what takes place is a withdrawal of the entire image that science has of itself. While it is true, as Thomas Kuhn proposed, that symmetry is perpetuated as any other paradigm via the education of the scientist within the existing scientific and social systems, the reasons for this radical re-thinking of the image of physics are not the counter-instances that Kuhn had indicated in his analysis as the origin of a shift.[37] Instead, the shift that Prigogine proposes has an onto-epistemological origin. His question is a philosophical one, concerning the *image of nature* adopted as the platform for asking specific experimental questions.[38] The

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[37] Cf. Thomas S. Kuhn, *The Structure of Scientific Revolutions* (Chicago, IL: The University of Chicago Press, 1996).

[38] Prigogine makes direct reference to the debate between Heraclitus and Parmenides, which opposes an evolving image of nature to a static and solid one. Cf. the interview at the 22nd Solvay Conference, https://www.youtube.com/watch?v=MnD0IlBvgO4 last amended May 2011, accessed on June 6, 2016.

original approach brought by Prigogine has been to pose the question from the angle of the mathematical model chosen for organising the experiment and representing the data. The statistical path adopted by Prigogine, diverging from all accepted positions, led to a universe radically different than the one pictured by physics built on integrable models. Indeed, it is precisely the ontological notion of *essence*, of which symmetry is the dynamic expression, that crumbles here. Yet, this is not because science has brought new findings that undermine it.

In fact, this would still attribute to science a privileged position in front of nature and therefore a hierarchical advantage with respect to philosophy; while at the same time retaining the empirical as the ultimate proof for abstract theory – thereby perpetuating dualism. Rather, the shift takes place at the level of *certainty* posed as the ground; that is, at the level of the epistemological image that ontology expresses. At the same time, this is not a solipsistic position that would reduce the world to the subject's projection. To the contrary, it stems from matter, from that which *matters* in the quest of science, the consequences implicit in the model - in this case the mathematical model chosen for asking questions and refuting objections. Sitting at the heart of science here one finds an exquisite philosophical problem, which leads directly to the problems raised by the Kantian *phenomenon*.[39] In fact, this amounts to an ontological shift. The move is not towards installing a new paradigm, but it exposes the dimensions of the paradigm as a *generative event*; moreover, it speaks of paradigms in the plural. That is, it is a shift in the very notion of paradigm, rather than of the interpretation of nature this expresses; a shift not about how truth is claimed of an object or fact, but concerning the possibility and the limits of claiming truth in general.

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[39] Supra: This will be addressed on Chapter 4. Suffice here to say that in spite of the criticism that Stengers directs at Kant for the a priori universality he had attached to the epistemological dimensions of experience, there remains that these dimensions constitute and inevitable *degree of roughness*, intrinsic to the emergence of all phenomena, which is precisely the generative potential that Stengers finds in Deleuze's speculation and in turn she attributes to the factish in the synthesis of new world/reality. The thesis will suggest that this roughness is necessary for any coming to presence of the present, and as such it brings the domain of aesthetics to the fore as essential for existence, rather than just contingent appearance. However, as will be seen, this coincides neither with aesthetics as the categories of perception, nor with aesthetics as a form of judgment.

This is where Stengers' analysis does not simply repeat Kuhn's argument. Not only because she shows how the problem at stake is one of *choices* rather than simple repetition via education interrupted by "extraordinary" moments of disorder *between* paradigms (ordered periods of science), rather because she shows how Prigogine while still proposing a new theory, is not moving in between the paradigms. That is, Prigogine is not simply passing to a new truth, disproving and excluding the previous model. Rather, he reaches and dwells upon the limit of the concept of paradigm. Indeed, –following on to Stengers- what has taken place is not a simple or linear shift, as Kuhn's would have had it, but something more radical: a shift in the very notion of paradigm. How truth is *constructed* and accepted is not a mere issue of recognizing that knowledge is limited and accepting its weakness.

On many points Stengers overlaps with Kuhn. Yet, Kuhn's argument remains on a strictly epistemological terrain; the analysis of science maintains the subject, the object, and the practice as separate. Kuhn sees a linear replacement of one paradigm with another; the period of "extraordinary science" is "between" steady ordered periods of quiet and obedient repetition. Kuhn does not dwell, nor wants to hesitate in the extraordinary – a period most uncomfortable for the scientist, where the philosopher would be limited to point out once again that things are changing without the possibility to say or add anything else, let alone intervene. Kuhn does not dwell on the logic of such change, or on the logic specific to the new paradigm that is becoming installed. He is content with the idealization of the shift into a generality: order becomes too cumbersome to justify –too many counter instances- and breaks up; a new order progressively sets in to include the counter instances that are now in continuity with the new paradigm. That is, the solution proposed by Kuhn is the traditional ontological abstraction, based on the assumption that there is one universal logic encompassing the events of science.[40] The epistemologist would only wait to *recognize*

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[40] The subtleties in the failure of Boltzmann and in the shift that Prigogine was able to bring about would have gone unnoticed in Kuhn's structure. This is because Kuhn's structure reflects the deterministic scientific position

when this manifests itself, without any openness to the heterogeneity that an emerging notion of paradigm as factish lets through.

Reconceptualising Dynamics Without Dualism - Prigogine's path had been to shift the focus from the authority of the theory of physics onto the counterfactual problem raised by the relevance of the approximations required to make the experimental results of the practice fit the theory. However, this must not be understood as yet another swing of the dualist pendulum between concept and object, one which would reject the primacy of language or the discourse in favour of the immediate evidence given by matter.[41] In fact, Prigogine's move is a step out of the binary paradigm altogether; a step, which in the light of Stengers' interpretation, echoes the "spring and let go" with which Heidegger described the attempted to exit the metaphysical capture (enframing) brought by rationality and determinism, which the dualism concept-object embodies.[42] As will be seen, Prigogine and Stengers do not limit the counter-actualization to this *exit*. Indeed, the de-territorialisation that the reconceptualisation of dynamics brings about reaches the core of the *speculative* interpretation of ideas as problematic that is presented by Deleuze in the discussion of the Image of Thought (ideas not progressively abstracted from the empirical, but *encountered* – and, as Stengers will later develop, actualised on the ground of their relevance).[43] That is, Prigogine's move *undoes* the event of measurement installed by the practice of idealisation enacted by linear physics (symmetry and equivalence). This is a reaching towards the moment where the event takes place (that is where it *makes* place, makes sense, territorialises). And yet, not a move reaching the source or ground of actualization, but also

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that disqualifies all that does not belong to the theory as myth and opinion, and does not consider the possibilities that other models might be parallel to the ruling one.

[41] Supra: Although this shift will introduce a materialist reading of the problem of sense and its logic, the meaning attributed to the concept of matter and of materialism will undergo such a reformulation that it is precisely the dualism that opposes it to discourse or ideas which will succumb; Cf. Chapter 4 here.

[42] Cf. Heidegger, "The Principle of Identity," in *Identity and Difference*, 23-41; and "The Question Concerning Technology" and "The Age of the World Picture," in *The Question Concerning Technology and Other Essays*, 3-35 and 115-154.

[43] Cf. Deleuze, "The Image of Thought" in *Difference and Repetition*, 164-213. In the abstraction of the transcendental from the empirical, that here Deleuze keeps at a distance, one still hears the inductive processes towards a unity of nature of early science, which still echoes in Kant's transcendental forms of intuition and ideas.

not a move aiming at the tangent point of indeterminacy and difference, where the limit is the *zero* of all determinations, nor a counter-effectuation towards the virtual. Although Isabelle Stengers later on will embed this counter-actualization in a concept of possibility, which she construes on the base of Deleuze's virtual,[44] Prigogine is not immediately concerned with this further ontological turn; nor this would open particularly new or alternative avenues of interpretation of the theory of chaos.

As was seen in Chapter two, the problem Prigogine faced was constructing a theory of transformations (thermodynamics) without reducing time to the by-product of approximations and, at the same time, without contradicting dynamics or quantum mechanics. In fact, Boltzmann's failure –which Prigogine had set off to redress- had shown that the irreversibility of time could not be derived from an image of dynamics constructed around the concept of conservation and sameness. Therefore the explanation for temporality required rethinking dynamics itself.

This approach is at the root of what will become the cosmopolitical notion of *resistance* for Stengers.[45] Resisting the foreclosure of homogeneity of science, which is the installation of a hierarchy and a process of disqualification of different practices, can only happen in such a way that it can not be itself disqualified as non scientific. That is, hesitation can only open a space of resistance on the same territory and with the same conceptual tools of the epistemological hierarchy it needs to resist; that is, from inside the same onto-epistemological organization and forms of colonization.[46] This is precisely what Prigogine did. His renegotiation of temporality is not done *against* dynamics, but through an

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[44] For the argument about the *possible* and the *probable* Cf. Stengers, "Scientific Passions," in *Cosmopolitics*, Vol.1, 1-13, and 263n10.

[45] Cf. Isabelle Stengers, "The Cosmopolitical Proposal," in Bruno Latour and Peter Weibel eds. *Making Things Public*, trans. Liz Carey-Libbrecht (Cambridge, MA: MIT Press, 2005) 994-1003; and Stengers "Wandering About Materialism," in *The Speculative Turn*, 368-380.

[46] Regarding the foreclosing character of an idealising epistemology that subsumes everything through approximation (the linear model of dynamics) Stengers writes: "to resist a likely future in the present is to gamble that the present still provides substance for resistance," that is acting from the same terrain that is captured inducing a de-territorialisation rather than seeking an external position, or Archimedean point from which to mount the resistance. Cf. Stengers, *Cosmopolitics*, Vol.1, 10. The same impossibility of a third place from which to mount political action was described by Gilles Deleuze in "Postscript on The Societies of Control," in *October*, Vol. 59. (Winter, 1992), 3-7.

"enlargement" (reconceptualization) of dynamics that includes both the fundamentals of rational and quantum mechanics and irreversible temporality. As was seen, the shift involves stepping out of integrability and taking the metastable equilibrium in the behaviour of ensembles as the primary unit of physics.[47]

3.2 The Probable and the Possible

In her interpretation of Prigogine's work, Isabelle Stengers goes beyond the undoing effect that the reconceptualisation of dynamics has on the image of matter and the challenges this raises for the deterministic paradigm, thus reaching the image of science and the ontological paradigm that supports it. The interpretation of this counter-actualisation, as she presents it, points to Deleuzean ontology (difference) and to the non a priori logic that makes rhizomes cohere without concepts or identity.

In this move hides the risk of repeating an ontological approach that privileges the problem of passing from nothing to something thought as primary and pure, without taking into due account the importance of temporal and logical irreversibility that Poincaré, Prigogine, and Mandelbrot have highlighted following the intrinsic self-constraints of the process of the organization of the present (finitude). That is, it points once again towards ontological idealisation. This chapter instead aims to show how the aesthetico-epistemological question *how are things thus rather than otherwise* is at least equally important in the explanation of the present as the purely ontological question *why something rather than nothing*, and should not be relegated to the contingent level, somewhat giving precedence to the question of Being without material and historical constraints. The aim is to clarify how the concept of possibility, the possibility of the sense one encounters, cannot be *abstracted*, even if just in a transcendental or virtual manner, from the contingent forms and determinations of historical existence. In other words, as was seen in Chapter 2, what is possible in the present is constrained by the history of the

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[47] Cf. Ilya Prigogine, "Epicurus' Dilemma" and "The Laws of Chaos," in *The End of Certainty*, 9-56 and 89-106.

process that has led to its organization and is therefore irreducible; it cannot be explained, let alone reduced, only on the basis of a purely ontological structure.

Following her interpretation of the shift introduced by Prigogine as an event, Isabelle Stengers needs to explain in which space such an event can take place. It is here that her interpretation takes a Deleuzean turn and the counter-actualisation is presented as an ontological issue.[48] Stengers differentiates between *probability* and *possibility*, renaming thus the same distinction that separates the *possible* and the *virtual* for Deleuze.[49] Possibility belongs to the regime of representation, it is that which only lacks reality, as "what is presupposed by the measurement device assumed by dynamics: a body can have any possible position or velocity; measurement occasions the transition from the possible to the real of one of those values". The virtual, on the other hand, translates into "actualization" which is "associated with creation," this implies a "change in kind, not the determination of a pre-existing possible." On the other hand, calculating probabilities assumes "the conservation of whatever the calculation has been constructed from" (sufficient reason) and demands that that conservation is maintained, precisely as the syntaxes of the Hamiltonian

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[48] Stengers had already interpreted the entirety of science through the prism of the Deleuzean event of actualisation. This is one of the key concepts that animate her work. The case for science becoming installed as an event is described in particular regarding the process that brought the Galilean experiment to constitute the basis of both the methodology and the truth in science; this will also be the basis on which Stengers can propose her notion of *constructivist* truth. Her question then becomes how to produce a new event, which new factish can act with the same authority as Galileo falling weights to open science to new ways of questioning. As will be seen later, this is also the pivot on which the intrinsic creativity of practices can be brought to the fore under the frame of aesthetics rather than rationality. Cf. Isabelle Stengers, "Science under the Sign of the Event," in *The Invention of Modern Science*, trans. Daniel W. Smith, (Minneapolis, MN: University of Minnesota Press, 2000), 71-87.

[49] Isabelle Stengers makes direct reference to Deleuze's virtual and counter-actualisation in several passages of *Cosmopolitics*. The most relevant for the discussion of possibility are found in *Cosmopolitics*, Vol.1, 263n10, where she explains that her reason for translating the Deleuzean opposition of *possible* and *virtual* with *probable* and *possible*, is to make more explicit the connection of this ontological problem with the practices of science; and in *Cosmopolitics*, Vol.2, 38, where she highlights how actualisation is a *creative* passage rather than the representation of the *same*; lastly, in "Transition to the Limit," in *Cosmopolitics*, Vol.2, 284-300, in particular, 442n21, where Stengers interprets the transition to the limit of physical properties and the changes of state of matter in the light of the counter-effectuation presented by Deleuze in the "Twenty-First Series of the Event" in the *Logic of Sense*; in the same footnote Stengers refers also to Deleuze and Guattari's *What is Philosophy*, indicating how the notion of *function* concerns not only scientific propositions, but also those functions that "organisms actualise" and counter-actualise towards an abstract state. As it will be seen, this constitutes a crucial difference with the thesis main proposition of finite possibility. Cf. Gilles Deleuze, *The Logic of Sense*, ed. Constantin V. Boundas, trans. Mark Lester and Charles Stivale (London: continuum, 2004), 169-175; and Deleuze and Guattari, *What is Philosophy*, 159.

equation demanded that the totality of energy is retained. The *probable* is that which can be *reduced*, is that which permits to *calculate* "different possible results."[50] The probable is a set of predefined possibilities out of which one, or at least a smaller more precise range, will be selected. The probable implies an a priori reality that is simply not *yet* known. It is a concept that still functions within the paradigm of objectivity, albeit one weakened by the limits of approximation.

The possible, in the sense of the Deleuzean virtual that Stengers borrows, is fundamentally different. It is the radically diverging image of the object or present; the indeterminate potential, which exists not as a beyond but at the *limit*, the Being of entities, which as Deleuze says "*differentiate themselves from it, while it does not differentiate itself from them*," the univocity of the event (or the event that events can happen.)[51] This is one of the pivots on which Stengers can construct science as an event both as the emergence of science and the specific distributions associated to individual discoveries.

The possible-virtual does not support a linear reduction process. Its passage into actualization, as Deleuze describes it in the "Asymmetrical Synthesis of the Sensible," is the passage from the *incommensurable* to *measure*, from the intensity to extension; a passage, which Deleuze describes as an inversion, an "upside-down" relation; a paradoxical equation (inside-out).[52] No calculation takes place in the process of actualization. The probable would require linearity in its realization, a process of exclusion based on the principle of identity and non-contradiction, which would simply consider and discard each option out of a totality. The critique Deleuze often moves to Leibniz's notion of incompossibility echoes here.[53] The possible instead concerns *quality*; or better actualization is the passage from quality to quantity, which as such does not have to do with calculation or non-contradiction because it does not have to do with existing distributions before it happens and distributions

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[50] Cf. Stengers, *Cosmopolitics*, Vol.2, 89.

[51] Cf. Deleuze, "Difference in Itself," in *Difference and Repetition*, 36-89; and Deleuze, "Twenty-Fifth Series of Univocity," in *The Logic of Sense*, 203-207.

[52] Cf. Deleuze, "Asymmetrical Synthesis of the Sensible," in *Difference and Repetition*, 280-229.

[53] Cf. Deleuze, "Twenty-Fourth Series of the Communication of Events," in *The Logic of Sense*, 194-202.

take place. The possible is pure becoming, temporality without chronology; the concept without specific opposition, and therefore not negation, but difference. The probable refers to the ideal of objective knowledge, discovery, the possible engenders emerging events - invention; representation belongs to the first but not to the second, precisely because the transition is not linear, and there is nothing specific to translate from one to the other. (See also the emphasis Deleuze put on "gift" and "theft" versus the even economy of a priori reasons in the "Introduction" of *Difference and Repetition*). Nevertheless, the possible *is*. Although the virtual assumes a transcendental connotation, it remains within the realm of a binary ontology.

Chaos cuts across sciences. It introduces new relevance for mathematics. Questions are no longer only about "processes that explain a behaviour" but enter a "nomadic aesthetic, […] wherein the relevance of mathematics would become local and circumstantial."[54] Stengers exemplifies how the mathematical object is interpreted here as Deleuzean virtual:

> "The wave that forms on the surface of an ocean does not imply the theorization of the ocean as a whole but organizes its own questions. The ocean thus loses its status of "cause", for which the wave would be a consequence. Rather it is defined solely in terms of conditions that must be satisfied for the wave to be produced. Milieus other than the ocean can provide meaning to those same conditions, in such a way that the "wave theorist" will be able to travel wherever the mathematical object "wave" can be actualized."[55]

Yet, chaotic behaviour very clearly pushes total unpredictability, the impossibility of forecasting that is associated with chaos, to the temporal horizon of the future. Chaos is not next to order; not philosophy, nor the present are on the edge of chaos – as it was seen with Ljapunov's temporal windows, order and predictability progressively fade out of focus. The operation of assimilating chaos with difference and place it at the edge is just an

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[54] Cf. Stengers, "The Laws of Chaos," in *Cosmopolitics*, Vol.2, 176-191.
[55] Cf. Stengers, *Cosmopolitics*, Vol.2, 163.

extension of the continuity that constitutes the paradigm of reductionist ontology, which is still in place for the modern as much as for the postmodern image of thought.

In fact one should ask why something that "organizes its own questions" as Stengers defines the factish that installs itself as a paradigm, cannot simply be without the need of an ultimate;[56] why, that is, there is the need of abstracting its attributes towards a pure disembodied and a-historical state. What makes it so uncomfortable for the philosopher to accept a presence or an organization that does not refer to something else that would justify it? Stengers raises this question with regard to the truth of science, showing how this is a political problem rather than an epistemological issue, only to return to the same paradigm when presenting the logic of her argument as an ontology, by interpreting the wave and the ocean as the product of a mathematical object presented as virtual (turning a method of description into an ontological entity). A wave not *caused* by the ocean as a whole, as the expression or representation of its identity, but as a mathematical object, the wave can *repeat*. And "milieus other than the ocean can provide meaning to those same conditions" in such way that the "wave theorist" will be able to travel wherever the mathematical object "wave" can become "actualized;"[57] only to counter-actualise at the same time precisely because it is transcendental (virtual) and there is always more to it.[58]

There is a risk here of playing a hand in favour of Meillassoux's field. To endow mathematics with a privilege which would make it the language of the absolute. Thus foreclosing not only science and knowledge as an event, but sense too. Prigogine had stated very clearly the heterogeneity of the laws of emergence; Stengers supported this in "The Science Wars," where she lays out what could be seen as the method or logic of her

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[56] Cf. Ibid., 163.

[57] Cf. Stengers, *Cosmopolitics*, Vol.2, 163.

[58] It is worth noticing that one of the sources of inspiration for the virtual's diverging and displacing image is Freud's notion of *phantasm* extended and idealized into an ontological structure; an image that although retroactive and unstable retains the role of identity. Cf. "Repetition for Itself," in *Difference and Repetition*, 90-163. That is, the extension as total logic of a process that belongs to a specific and local set of relations, in this case the emergence of the subject, is raised to the image or logic *tout court*. There seems to be a resistance or inability of ontology to think of possibility as something that itself emerges locally; when approaching the question of sense from an ontological platform, idealization always hides in disguise.

thought.[59] In other words, in adopting Deleuze's ontology, Stengers performs an *idealization of the mathematical model*, somehow clashing with the denunciation, she and Prigogine put forth, of the effects idealization had in setting up dynamics on the basis of the equivalences implicit in the Hamiltonian equation, thus projecting an unsatisfactory image of dynamics and nature. Deleuze had claimed that the "famous Copernican Revolution" operated by Kant, would "amount to nothing," if the encounter with that which stimulates thought is still presented as an a priori concept, albeit transcendental rather than speculative.[60] The same reversal seems needed here. Replacing linear causality with exponential chains and chaotic fugues would still amount to nothing as long as idealization is still in place and the fundamental relevance of augmented causality is disregarded.

As will be seen next, the rhizomatic logic that Deleuze and Guattari formulate in *A Thousand Plateaus* can still offer a valid key for the notion of possibility, provided its actualising and counter-actualising movements do not correspond to a relation to a transcendental limit or ontological ultimate. The thesis argues that it is time that the rhizome becomes un-rooted, detached from a tangent and continuous contact with difference. It is time to really show what it means to be *generative* as a factish that demands/imposes its reasons and expands its dimensions; a present that generates its meaning at the same time as it constructs the language that conveys that meaning; that is, the logic and the quality of art.

Counter-Actualisation and the Rhizome - To avoid foreclosing the finitude brought to light by non-integrability with an interpretation that still favours the ultimate, the thesis proposes a path where differentiation can operate finitely, without picturing possibility and the change this may engender, as a counter-actualisation that is primarily ontological; that

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[59] Cf. Stengers, "The Science Wars," in *Cosmopolitics*, Vol.1, 1-83. This is where the notion of factish is articulated, as well as the notions of *constraints* and the *humour of truth*, which constitute the prism through which Stengers reinterprets epistemology. For the humour of truth Cf. also Stengers, "Part II: Construction," in *The Invention of Modern Science*, 55-108.

[60] Deleuze made this claim referring to the Kantian transcendental idea, which he reinterpreted as genetic problems "encountered" in thought. Cf. Deleuze, "The Image of Thought," in *Difference and Repetition*, 164-208, in particular page 201 for the comment on the expansion of the Copernican revolution.

is, bringing the eternal return as an ultimate cause in immediate relation with the pattern of the present. This can only be achieved by shifting the emphasis from the counter-actualisation as an ontological structure to the finite aesthetico-epistemological organisation of the present, pointing to a radical finitude where historical differentiation cannot be pushed to the limit of pure difference without plunging thought back into abstraction.

With this, the thesis is not suggesting to replace an ontology of difference for an ontology of finitude. Rather, it suggests that, while ontology implies an exactitude that enables distribution and positioning to happen (that is sense), through a concept or principle of logic that enables a path to be drawn and therefore a ground to be established, finitude provides an equally valid and rigorous logic, without the need for a transition to an ultimate limit shared by all contingent instances (difference-Being as the common denominator). If the difference that is at work in Deleuze's counter-actualisation derives from the Heideggerian difference, where identity emerges in a relation that supports Being rather then being its attribute, finitude goes further. It shows that beings need explaining each time anew, heterogeneously and locally, without this heterogeneity being unified into a common horizon.

As was seen in Chapter 2, the exponential causality that emerges from Prigogine's work severs the continuity installed by a linear form of sufficient reason via the intrinsic finitude of all facts described by Poincaré. Prigogine provides a radical solution to this, because by proving from inside physics the impossibility of integrability (the impossibility of passing to the limit or absolute, from inside thought/ontology) he shows that there are areas of the universe, and of the universe of sense, that do not respond to the same logic of reducibility. The augmented causality is not only diverging from the economy of a priori definitions, but introduces a plurality whose main effect is to resist any form of common denominator. The continuity to the ultimate is an inheritance of the principle of sufficient reason that Deleuze retains in the notion of radical difference. Instead, as will be seen, the possible becomes a name for what is finite and *open*. This is to be understood in a manner at the same time simpler and more radical that the eternal return of difference that Deleuze

inherits from Nietzsche, as the quasi-cause that is at the base of the counter actualising movement chosen by Stengers as the logic for an epistemology not structured on universality.[61]

The argument that has emerged from Prigogine imposes to question if and how the possibility of change, and the possibilities along which change takes place, can be grasped not only as undoing actual order (counter-actualisation) towards the virtual, but rather as combining different given actual organizations; that is, passing from actual to actual.[62]

In fact, the problem should be turned around. Deleuze exhorts not to count upon any necessity for thought, rather to "count upon the contingency of an encounter with that which forces thought to raise up." Shifting the act of thought from representation to "genesis" and creativity.[63] Moreover, the object of this encounter "can only be sensed," it bypasses the orthogonal grid of a priori concepts of the intellect to engage directly with the trascendental. However, the emphasis of this encounter falls again onto "that by which the given is given" in the contingent encounter: "not a sensible being but the being *of* the sensible" (or "sentiendum", as Deleuze defines it, emphasising the 'ought' acceptation of the Latin gerund). That is, the contingent re-envoys to a divergent and unstable virtual image.

The genetic aspect of such an encounter is of critical importance for thinking possibility, both in onto-epistemological terms and in terms of aesthetic practices. Yet, in order to allow such practices to be genetic and creative in their own right, and with their own logic, the emphasis should shift onto the encounter with a textured given; with a pattern that

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[61] The possible becomes a name for what is *open*. But it is not an openness that becomes absolute as in Meillassoux. In fact, Meillassoux's openness is first open onto something, then this something becomes a place, and this place is then turned into an absolute (all arbitrarily; that is, it is not necessary to perform such ontological capture, other than for reasons of habit and capturing). Indeed, claiming that the *fact* that 'the world is' is itself absolute may enter an infinity regression, claiming that the *fact* of 'the fact that the world is' is absolute, and so on. This is the real onto-theo-logical risk feared by Heidegger of which his thought also ended up being victim through the ontologisation of difference. Instead the problem at stake here is how to be able to think open finitude per se, without any temptation to ontologise such openness. Cf. Meillassoux, "The Principle of Factiality," in *After Finitude*, 50-81.

[62] Deleuze denies this kind of passage, or rather demotes it to a contingent historical form of change that would be nothing but a bad repetition. What is primary -Deleuze writes- is the passage from virtual idea to actual forms of existence. Cf. Deleuze, *Difference and Repetition*, 260-274 and Gilles Deleuze and Claire Parnet, "The Actual and the Virtual," in *Dialogues* II, trans. Elliot Ross Albert, (London: Continuum, 2002), 148-152.

[63] Cf. Deleuze, "The Image of Thought," in *Difference and Repetition*, 176.

is no further reducible on pain of destroying it. As will be explained in this chapter, this does not constitute a return to the empirical or materialist frame that, as Deleuze says, is built upon the a priori image of thought and imposes recognition. On the contrary, it leads to the encounter with an object whose finitude cannot be counter-actualised ontologically as a transition to the limit (where the ultimate virtual is Being as difference). As will be seen, the "geometry of sufficient reason," that Deleuze invokes against the Euclidean geometry of the a priori, remains fundamental in the concept of possibility.[64] However, the discontinuity of this geometry cannot be entrusted only to the counter-actualisation of the actual present towards the virtual image that the encounter/engagement with this present has produced, without giving full relevance to the augmentation of causality that takes place outside the linear processes that have given rise to such present. In the geometry of sufficient reason, as Deleuze presents it, difference, is *tangent* to the contingency of the present. The eternal return reverts all traditional ontological structures; what was a ground or pineal point, to which contingent beings pointed, is turned inside out and becomes the horizon of difference encircling each contingent presence. The ontological ultimate is at the limit, the ever-receding horizon of the present. Yet, in the counter-actualisation this limit is next to the order, or pattern of the present, and weighs down on it with all the imposing authority of an onto-theo-logical ruler.

It is necessary to look again at the distinction between the *virtual* and the *possible* made by Deleuze, for it holds crucial clues as how to proceed, keeping in mind that this is the prism through which Stengers reads the counter-actualisation of the image of science and the production of the fact (scientific or otherwise). Possibility for Deleuze is "opposed to the real", while the virtual is real but not actual - "*the virtual is fully real insofar as it is virtual.*"[65] It is an image of the object, to which the object constantly returns and from which it continuously diverges; instead of acting as the a priori idea that lays out the space in

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[64] Cf. Deleuze, *Difference and Repetition*, 201.
[65] Cf. Deleuze, "Ideas and the Synthesis of Difference," in *Difference and Repetition*, 260-274.

which the object can move, it installs a relation of differentiation.[66] Possibility for Deleuze responds instead to the process of "realisation;" it responds, that is, to an a priori concept, which as opposed to the real is abstract. This would imply that passing from possibility to reality would be a sudden act of jumping from abstraction to existence (Deleuze's expression is "brute eruption"). Moreover, this passage would imply no difference between the two stages, since the abstract is already possible but simply not *yet* existent in time and space. It would instead amount to a relation of *sameness*, which returns the problem of existence to the paradigm of representation of an a priori concept, and therefore sets possibility in a dualistic relation with limitation (negative rather than difference), allowed to become real only if nothing opposes it. The process of actualisation on the other hand, is a differentiation or divergence from the virtual idea that –as Deleuze says- is dramatized in the actual.[67] The distinction that is thus set up is between the possible responding to the identity in the concept and the virtual as a "pure multiplicity in the Idea, which radically excludes the identical as a priori condition."[68]

It is on this understanding of the counter-actualisation as a return to the virtual of the actual, that the chaotic fugue can become associated with the image of the ontological limit: chaos as the transition to the limit or as the virtual state, and the emerged organization as its actualisation. That is, presenting a regime of differentiation where chaos assumes the role of the infinity of potential, or plane of immanence, and the actual is nothing but one individuation. In other words, this turns the chaotic behaviour, which -as was seen in Chapter 2- is not a state or a place, into the ontological ultimate and gives rise to the

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[66] Deleuze's inspiration for this image of the virtual is Bergson's memory: not an image formed after the perception of the object and becoming progressively removed from it along a linear timeline, but one coexisting with it in a circular and returning manner, expanding in concentric circles but never exhausting its potential. Cf. Deleuze, "The Actual and the Virtual," 150-1. Cf. also Gilles Deleuze, "Memory and Virtual Coexistence," in *Bergsonism*, trans. Hugh Tomlinson and Barbara Habberjam (New York, NY: Zone Books, 1991), 51-72. One can also detect an echo of Heidegger game of *revealing-concealing* here, which Deleuze mentions less often as his source. Cf. Martin Heidegger, "The Principle of Identity," in *Identity and Difference*, trans. Joan Stambaugh, (New York; Harper and Row, 2002), 23-41.

[67] Deleuze offers metaphors for this passage from a transcendental to the actual as larvae, embryos, even going as far as stating that "the entire world is an egg." Cf. Deleuze, "Ideas and the Synthesis of Difference," in *Difference and Repetition*, 268-9; and "Twenty-First Series of the Event," in *The Logic of Sense*, 169-175.

[68] Cf. Deleuze, *Difference and Repetition*, 263.

metaphors, such as the *edge of chaos*, that have radically misinterpreted it.[69] The notion of finitude, on the other hand, does not respond to this dualistic distribution; rather, it describes a present that is *positive* in itself, insofar as its existence cannot be reduced or abstracted, that is it cannot be counter-actualised ontologically on pain of being destroyed.

This brings a radical challenge to the image of the rhizome that Deleuze and Guattari build on the notion of virtual vectors of becoming, as actualisation and counter-actualisation. Nevertheless, the heterogeneity that they indicate as one of the properties of rhizomatic logic provides a key for the grasping of possibility outside metaphysics. What will become evident is that rather than a chaosmos, what is encountered are specific finite forms of organization, which allow specific and local forms of behaviour; not ontological counter-actualisation, but heterogeneous and non-reducible emergence. In other words, in the abdication of the universal one finds different avenues that lead to possibility; not mutually exclusive, but also impossible to absorb into one continuous form of ultimate cause (or difference). What will provide the key for this shift is the role that *conditions,* rather than concepts, play in the articulation of complex behaviours.[70] As will be shown, this reflects the notion of self-constrained chance introduced by Mandelbrot; and, as was mentioned earlier in the chapter, the shift from concepts to conditions in the logic of sense marks the passage where the reconceptualisation of dynamics becomes an ontological question. However, this does not necessarily lead to the same ontological structure of the

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[69] The sometime naïve metaphors of scientific language can be misleading if they leak into philosophical questions. A close reading of the science of complexity shows that the expression "edge of chaos" should not engender the image of a distribution or separation of chaos and order. Cf. Jeffrey A. Bell, *Philosophy at the Edge of Chaos: Gilles Deleuze and the Philosophy of Difference*, (Toronto: University of Toronto Press, 2007). In adopting this image of the edge, Bell makes explicit reference to the collaborative work of Prigogine and Stengers and goes as far as claiming that Deleuze formulates a metaphysics of dynamic systems. Cf. "Dynamic Systems," in Bell, *Philosophy at the Edge of Chaos*, 177-209. What is lost in these interpretations is that chaos and order are neither clearly separated by an edge, nor they are poles at the extremes of a pre-existing space. Gribbin had made clear that the edge of chaos is in fact an area of transition in the process, whose dimensions and time span are local, heterogeneous and fluid. Cf. John Gribbin, "The Edge of Chaos," in *Deep Simplicity: Chaos, Complexity and the Emergence of Life*, (London: Penguin, 2004), 104-135. This was also explained by Prigogine and Stengers regarding non-standard or chaotic attractors as behaviours rather than states. In fact, chaotic behaviour and the multiplication of bifurcations should be described as a degree of dissipation (entropy) rather than a location in a spatialised ontology. Cf. Ilya Prigogine and Isabelle Stengers, "Dal Semplice al Complesso" (From the Simple to the Complex), in *Tra il Tempo e l'Eternità*, 68-90.

[70] Cf. Prigogine and Stengers, *Tra il Tempo e l"Eternità*, 62-64.

differential virtual-actual, but to the *dimensionality*, which names a positive form of finitude. To be clear, finitude does not reintroduce a notion of possibility based on the passage from the general to the more determined particular, which Deleuze defines as negative limitation, aiming at Leibniz's notion of compossibility that, being built on the principle of non-contradiction, is the converse of identity.[71] In this light, for Deleuze and with him Stengers, only actualisation is presented as properly creative.[72] However, as will be seen, it is possible to read the process of incompossibility that leads to the present as a form of finite determination that needs not resting only, or perhaps at all, on non contradiction, which is essentially negativity, but it gains ground on the basis of relevance, as Stuart Kauffman points out, or indeed it speaks to the question of mattering that Karen Barad articulates as *diffraction*.[73]

It is important not to lose sight of the relevance this problem of possibility has for the practice and the thinking of art. Casting the mind to the stalling dichotomy between artistic medium and disembodied discourses that was laid out in the introduction, it is evident that Deleuze, and before him Heidegger, has set up a system where art still corresponds to the passage from the obscure and confused perception of the material object directly to the idea of unity of such matter, bypassing the clear and distinct concepts of the intellect or the enframing of rational reason (metaphysics);[74] a system, which -obviously- repeats the move of the Kantian sublime (that directly resonates with the post modern limit). This is not particularly problematic in itself. In fact, the concern that emerges regarding this structure is not so much the neo-romantic dualism between the present and an unattainable totality that

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[71] Cf. Deleuze, *Difference and Repetition*, 267.

[72] Cf. Ibid., 267.

[73] Relevance is one of key elements in the notion of "ontological emergence" that is put forth by Kauffman to explain the irreducible and heterogeneous growth of the biosphere network. As it will be seen, the solution he proposes to support possibility in the open regime of evolution is critical for the thesis and has direct links to the mattering and diffraction argument put forth by Karen Barad. Cf. respectively Stuart A. Kauffman, *Reinventing the Sacred: A New View of Science, Reason, and Religion* (New York, NY: Basic Books, 2010) and Karen Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning*, (Durham: Duke University Press, 2007).

[74] In the case of Heidegger the claim is actually explicit. Cf. Martin Heidegger, "The Origin of the Work of Art," in *Basic Writings*, ed. and trans. David Farrel Krell (New York, NY: Harper Collins, 1993), 193-212.

it repeats, rather it is with the fact that once again the sensuality of matter and the genetic logic of its intrinsic constraints (its limitations as positive dimensions) are allowed to function and make sense only within the space of a projection towards the ultimate – even if in this case they gain meaning precisely from the fact that such ultimate is somewhat evanescent.

As will be seen later in the chapter and more in detail in Chapter 4, the issue at stake is not to react with a swing to the opposite end of the spectrum, assuming a materialist position that returns the authority to the object and makes the concept secondary (just as an epiphenomenon), rather the solution lays outside all dualism. It is indeed the notion of dimensionality, which – it can be advanced- acts as a finite pattern that does not respond to a logic structured as the present and its limitations or otherness, but rather as the present and the potentials encountered in the repetition of its texture.

3.2 The Rhizome and the Adjacent Possible; the New Mechanics

In the light of the abdication and withdrawal that have liberated the landscape from the absolute claims and exposed that reductionism is not the only paradigm available, the question of possibility can be posed anew. Isabelle Stengers evokes an "ecological possible" that "entails the production of different modes of relation." She writes:

> "I want to create an interest, through the *question* of her triumph [the Hamiltonian formulation of dynamics], in all the different possibles that the history of this triumph has silenced" and "prepare the ground not for a conversion of the physicists [to a new truth,] but for a moment of hesitation."[75]

This hesitation for Stengers enacts the Deleuzean counter-actualising movement. The possible arises in a moment of slowing down that leads to renegotiate the always-already foreclosed image of both nature and thought. In fact, thinking for Stengers coincides with resisting an accepted explanation or, as she poses it, resisting "a future that presents itself

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[75] Cf. Stengers, *Cosmopolitics*, Vol.1, 179.

as obvious, plausible, and normal."[76] However, resisting the likelihood of the future (its linear probability based only on subjective limitations) means also to "gamble that the present still provides substance for resistance." While this resistance is not mounted from a third or external standpoint (no utopia awaits us over the horizon), it also does not need to imply an ontological journey to the limit. In fact, thinking or resisting moves from the very roughness of the pattern of the present, questioning the consequences and the relevance of such roughness. As will be seen, this substance that provides both the material and the questions for ontological resistance is the same substance that feeds artistic practices; better still, the logic that permits resisting is shared by both epistemological questions and artistic creativity. Resisting epistemologically and exploring possibilities of making sense through artistic research aren't as distant as they are presented when articulated inside an concept-object structure.

The image of matter and its plural logics, which emerge from the counter-actualisation induced by Prigogine and Stengers, seems to express a rhizomatic ecology: heterogeneous possibilities resonate generating new practices, places, and territories that can be inhabited while both permitting and demanding engagement according to their specific relevance. The speculative approach that Stengers inherits from Deleuze becomes immediately ethical and political as well as aesthetic, and raises claims for a new logic. However, the rhizome is not a metaphor without risks. The thesis receives Stengers' invitation to hesitate and, to prevent foreclosing the innovation at hand, in turn pauses this re-ontologisation of possibility, as the pure possibility (or virtual) to which the rhizomatic organization would be constantly *tangent*. What emerges here is in fact a new kind of rhizome: certainly an expanding network, but one not directly drawing from a possibility that exists on the ontological level. It is a fundamentally temporal and metastable organisation, rather than one defined spatially by its relation to the limit; that is, an organisation progressively emerging from multiple layers of complexity, rather than in direct contact

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[76] Cf. Stengers, *Cosmopolitics*, Vol.1, 10.

(tangent) to pure returning difference. The key for answering this exhortation, is the *materiality* of the practice, be it the practice of science or any model for investigation and construction, including artistic practices. Stengers had highlighted how the constraints that shape the practice (for instance the syntax of dynamics seen in Chapter 2) are the pivot on which the reconceptualisation of physics takes place, and act as the ground from which this can impose the counter-actualisation of the image of science and ontology. What is crucial, and at the same time it seems to have been left by the wayside, is that while the materiality of the practice is constructive and cannot be rescinded from the image of truth, this materiality (or finite roughness) must be upheld for the concept of possibility as well. This is the epistemological aspect and effect of the self-constrained iterations described by Mandelbrot: the materiality of the present is the pattern upon which all speculation can take place; it is both the material and the limit of such speculation.

Prigogine and Stengers pointed out that the reconceptualisation of physics they proposed embodies an evolutionistic logic that can not be thought of in terms of *concepts*, which –they say- would answer the scientist's question by laying out the space of the answer a priori, but rather in terms of *conditions*, as the requirements without which the problems could not be posed.[77] The notion of conditions plays a fundamental role in the description of complex systems and regimes of emergence. It replaces a priori concepts for something that is equally binding and determines evolution, yet without pre-establishing the space in which this will unfold as concepts would. This is the pivot on which the reconceptualisation becomes an ontological question (the counter-actualisation where physics loses its status of model science and in turn reductionist ontology is undermined by its withdrawal –as it was shown earlier in this chapter). Stengers raised this point again in *Cosmopolitics*, where the interpretation of conditions meets with the Deleuzean notion of

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[77] Cf. Prigogine and Stengers, *Tra il Tempo e l"Eternità*, 62-64. Isabelle Stengers will further qualify the notion of *conditions* distinguishing it from that of *constraints*. While neither must be grasped in a deterministic acceptation, conditions can be said to be properties of the environment beyond the scientist's control, while constraints –as will be seen in Chapter 4- belong to the experimental environment of the laboratory and display a far more creative and genetic character. Cf. Stengers, *Cosmopolitics*, Vol.1, 43 and 76-77 and "The Politics of Technical Inventions," in *Cosmopolitics*, Vol.2, 340-350.

the virtual, as well as with the speculative approach to concepts that Deleuze introduced to replace the a priori as an image of thought.[78] This becomes a fundamental element in the interpretation of chaotic behaviours and the transition to the limit, and contributes to explain the openness of the present. In fact, the passage from concepts to conditions is critical for a formulation of possibility free from the metaphysics of identity. To articulate this in further detail, the thesis turns to the work of theoretical biologist Stuart Kauffman.

Kauffman presents a new path into the problem of irreducibility and the emergence of sense, calling attention to the fact that Darwinian evolution is not only a process of selection, but also one of self-organisation in continuous feedback loop with selection. This interpretation is articulated through the concept of *adjacent possibility*, which -Kauffman claims- expands well beyond biological evolution extending to all dynamic realms of existence to include history, economy, and culture.[79] Kauffman's work develops the same questions of non-integrability and incompleteness seen so far in the thesis, giving prominence to the impossibility to deduce biology from physics. In this sense, his work is parallel to Prigogine's concerns regarding the incompatibility of dynamics and thermodynamics. Both share the heterogeneity and locality of behaviours as an essential key for the understanding of emergence, and both see information entropy as the barrier that prevents any possible retracing or reversing of the present. While Prigogine was concerned with the role of dissipation of energy in the processes of emergence and the obstacle this raises for reductionism, Kauffman's emphasis instead points at the logic of self-organisation in such processes. That is, Prigogine concentrated on proving why the emergence of order in a system could not be smoothly reduced to the initial conditions, Kauffman on the other hand studies how order can emerge thanks to accelerating autocatalytic processes without external or intelligent design, and equally without entrusting

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[78] Cf. respectively Stengers, *Cosmopolitics, Vol.1*, 38, and "The Laws of Chaos," in *Cosmopolitics, Vol.2*, 176-191. For the notion of speculation Cf. Deleuze, "The Image of Thought," in *Difference and Repetition*, 164-213.
[79] Cf. Kauffman, "The Evolution of the Economy," in *Reinventing the Sacred*, 150-176.

it to the role of chance.[80] Prigogine too rejected the interpretation of chance as a form of causality in disguise that could give rise to a new deterministic interpretation of emergence. He pointed out that chance implies an intrinsic impossibility to predict if and when it will make its appearance and induce resonances and expanding chains of augmented causation.[81] The adjacent possible instead has a fundamental role in these processes. It names a logic for the expansion of the network that is both radically *finite* and intrinsically *open*. This shares many similarities with Deleuze and Guattari's rhizome, but also some fundamental differences, which set it aside from a primarily ontological interpretation of possibility. On the one hand, the particular relevance that the regime of adjacent possibility gives to the notion of conditions, where the finitude of the present merges with the genetic character of speculative concepts proposed by Deleuze, is inherently creative. On the other, it undermines the concept of counter-actualisation as an ontological transition to the limit, which is instead key in the rhizome's lines of flight, and shifts the emphasis on to the notion of augmented causality introduced here in Chapter 2. In fact, Kauffman's argument points at the same intrinsic limitations in the passage to the ultimate that were already highlighted in the notion of self-constrained chance formulated by Mandelbrot. If chance is self-constrained in the recursive interpolations, as Mandelbrot had described, any counter-actualisation can only be partial; that is, it cannot amount to a total or absolute reset of the parameters that organise the present. This is crucial for an alternative and yet rigorous logic of possibility, which is neither the image of an a priori, nor tangent to the ontological limit of difference (this rigorous logic is what demands the status of *mechanics* for possibility, which gives the title to this chapter). As will be seen, this constitutes the critical step upon which

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[80] Cf. *Stuart Kauffman, The Origins of Order: Self-Organization and Selection in Evolution* (Oxford: Oxford University Press, 1993). This differs from other theses such as Monod's, where the role of randomness is more accentuated. Cf. Monod*, Chance and Necessity*. What is key for Kauffman is that evolution must not be interpreted through a reductionist prism. The emerged coherence of life is more that just particles in motion. In this light, Kauffman's work also differs from Dawkins' notion of "selfish gene" where life and the present would be nothing but epi-phenomena without a legitimacy of their own. Cf. Richard Dawkins, *The Selfish Gene* (Oxford: Oxford University Press, 1999).

[81] Cf. Alvin Toffler, "*Foreword: Science and Change*," in Prigogine and Stengers, *Order out of Chaos*, XVI*.* This points towards a different interpretation of chance than the quasi-cause or difference proposed by Deleuze in *Difference and Repetition*.

the pattern of the present acts as a condition and a constraint. Yet, these must not be grasped as limitations, as a negative limit expressing non-contradiction, rather as *positive*; which, in fact, is genetic and creative. Constraints constitute the pattern of the possible, thus retaining the speculative approach to the materiality of the practice that Stengers proposed on the base of Deleuze's speculative concepts. In this light, conditions and constraints will have to be grasped anew as the dimensions of the present, preparing the terrain for the introduction of *dimensionality*. As will be seen, the notion of adjacent possible is key to both thinking and practicing possibility in a regime of emergence; a methodology entirely outside reductionist ontology.

Kauffman develops this interpretation of possibility from Darwin's notion of pre-adaptations.[82] The argument revolves around the emergence of functions for organs. The problem is not posed directly in terms of the organ's origin, but concerns how the process of natural selection lets through its filter more than just the function that has proven successful and is therefore reproduced. Other features become established, which for the purpose of the selected organ's function are just side effects, since they have "no selective significance" in the environment where the main function was selected thanks to its causal relevance. The key to Kauffman's argument is that in a different environment encountered entirely by chance, such surplus features may prove to have their own selective significance and therefore become selected as primary functions. Likewise, selected functions may combine with other selected functions giving rise to more complex organs in a process of self-organisation that proceeds "a-causally."[83] What was incidental and contingent in one environment can become necessary in another; and, if selected, will lead to the emergence of a "novel functionality" that in turn will have irrelevant features, thus continuing the loop. Moreover, this selection of secondary features constitutes a diverging turn from the linearity of causality. Each function behaves like a domino tile with potentially multiple

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[82] Cf. Kauffman, "Breaking the Galilean Spell," in *Reinventing the Sacred*, 129-149.
[83] For the notion of "a-causality" Cf. Kauffman, *The Origins of Order*. Cf. also Stuart A. Kauffman, "Can A Changing Adjacent Possibility Acausally Change History?," last modified February 25, 2010, accessed July 7, 2016, http://www.npr.org/sections/13.7/2010/02/can_a_changing_adjacent_possib.html.

heterogeneous exits. Such turns, Kauffman points out, cannot be deduced; neither from an axiomatic science such as physics nor from the macroscopic level of organic compounds and life forms in the present. In fact, in most cases they cannot be deduced even from the very function from which they depart. Through this extremely simple mechanism any organisation flows into a new configuration that is next to it, in the sense that it implements nothing more than what is already a feature of the present (in this sense the possible is adjacent) and yet it generates change.[84] The adjacent possible is a simple but extremely powerful engine for the generation of novelty, or indeed emergence. In fact, Kauffman goes as far as claiming that it acts as the engine for history, in a move that as it will become clear is neither teleological nor reflects historical materialism.[85] It is important to point out that this a-causal installation of possibility on the ground of relevance speaks directly to Karen Barad's concept of *diffraction*, which as will be seen later, helps to explain how something can *become necessary retroactively*.[86]

There is more. Kauffman defines the selected feature and its side features as "actual."[87] This must be seen in the light of Kauffman's theory of collectively autocatalytic sets, his main contribution to theoretical biology.[88] These are processes of self-organisation that accelerate towards a critical threshold (phase transition) past which "the emergence of

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[84] The classic example for this process of expansion into the adjacent possible is the existence of lungs, which organisms that return to water find can be filled either with air or with water, thus becoming a flotation bladder, which in turn permits fish to control the depth at which they swim. Kauffman brings further examples for non-biological expansion, such as a communication environment where television is widely diffused, several TV channels exists and offer an abundance of programming, there the remote control becomes a useful tool. A more contemporary example could be brought by the advent of digital photography, which in itself is nothing but a representation of analogue technology, yet the immediate circulation of the digital image has given rise to new phenomena and economies such as Instagram, which was not implicit in the digital rendition of the image. Cf. Kauffman, "The Evolution of the Economy," in *Reinventing the Sacred*, 150-176.

[85] Cf. Kauffman, *Reinventing the Sacred*, 64.

[86] Cf. Karen Barad, "Diffractions: Differences, Contingencies, and Entanglements That Matter," in *Meeting The Universe Halfway*, 71-96.

[87] Cf. Kauffman, *Reinventing the Sacred*, 64.

[88] Cf. Kauffman, "The Origin of Order," in *Reinventing the Sacred*, 44-71; and Kauffman, "The Emergence of the Neo-Darwinian Synthesis," and "Part 1: Adaptations on the Edge of Chaos," in *The Origins of Order*, 3-15 and 39-283.

life becomes a near certainty."[89] Kauffman suggests that even when beginning with a state of disorder randomly chosen, random connections between parts become progressively established, forming clusters, then clusters of clusters of increasing size, which also feedback into the game of random connections. This process continues until it spontaneously induces phase transition: "then something magical occurs. Given enough mid-size clusters, adding just a few more connections will connect most or all midsized clusters into a single giant cluster."[90] Phase transition –Kauffman claims- is itself emergent.[91] Moreover, each of these states is actual and whichever connection is reachable in a single step from this actual is its adjacent possible.[92] However, the new emerged possibility does not respond to a virtual image. The new entity simply does not emerge until the coherence of its properties and their new acquired relevance *makes sense*; that is, until a side feature of a selected function meets with a situation (environment or other feature) where it can be implemented and therefore become meaningful and causally relevant. This names a coherence which -Kauffman says- is an ontological form of emergence. It is a process of making sense that concerns a "real entity in the universe," something that exists in itself and cannot be reduced to "nothing but particles in motion." "Ontological emergence" is thus distinguished from "epistemological emergence", which instead concerns "an inability to deduce or infer the emergent higher level phenomenon from the underlying physics."[93] These interpretations of emergence speak to Gödel's incompleteness and more specifically to the re-elaboration that mathematician Gregory Chaitin proposes of it from the point of view of the compressibility of the information necessary to predict or define a priori the evolution of the system (simplicity).[94] In other words, the adjacent possible is a

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[89] Cf. Kauffman, *Reinventing the Sacred*, 60. For an extensive study of the logical aspect of the feedback loops at play in these processes of emerging order Cf. Douglas Hofstadter, *Gödel, Escher, Bach, an Eternal Golden Braid*, (London: Penguin, 1979).
[90] Cf. Kauffman, *Reinventing the Sacred*, 61.
[91] Cf. ibid., 62.
[92] Cf. ibid., 64.
[93] Cf. ibid., 34.
[94] Cf. Gregory Chaitin, *Meta Math! The Quest of the Omega* (New York, NY: Random House, 2006).

mechanism where possibility passes from *actual to actual* without the need for the ontological counter-actualisation that would reach a liminal or transcendental horizon, which would act as the virtual identity for the new possibility. That is, the possibility adjacent to the present is itself emergent, rather than pre-existing at ontological level - a solution that could not avoid leading back to metaphysics.[95] The directions that evolution follows are not paths in an existing space but the creation of both path and space; that is, place.

Another aspect of the mechanism of the adjacent possible needs to be underlined in order to grasp how far from a linear logic Kauffmann is taking the notion of possibility. The flow of the present into the adjacent possible must not be assimilated to the work of attractors as it is seen in dynamics. In fact, it differs radically from the chaotic attractors encountered in deterministic chaos.[96] As was seen in Chapter 2 regarding Poincaré's non-integrability, attractors imply the convergence of the evolution of the system onto a point (standard attractors) or an area in phase space (chaotic attractors). Instead, Kauffman stresses, that the limitation of predictability of deterministic chaotic behaviours is "emphatically not the same as that at play in Darwinian pre-adaptations."[97] In deterministic chaos the space defined by the boundary conditions is known beforehand and the limits of prediction are due only to the intrinsic finitude of the precision of measurement, as indicated by Poincaré. Chaotic behaviour, that is, takes place within a defined region of phase space. This -Kauffman says- contrasts sharply with the process of pre-adaptations flowing into the adjacent possible. Pre-adaptations do not move inside a pre-existing space. In this case, while the emerging network converges onto one organism, the space is not only not known in advance, but in fact it does not exist in advance of the expansion of a given pre-adaptation into its next possible function. Contrary to the behaviour of attractors in phase

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[95] This passing from actual to actual, which characterises ontological emergence, marks a retroactive logic of the possible that was already sought by Bergson in his attempt to avoid a metaphysical solution for the relation between possibility and reality. Cf. Henri Bergson, "Introduction (Part I) Growth of truth. Retrograde movement of the true" and "The possible and the real," in *The Creative Mind; An Introduction to Metaphysics,* trans. Mabelle L. Andison (New York, NY: The Philosophical Library, 1946), 9-32 and 107-125.

[96] Cf. Kauffman, *Reinventing the Sacred*, 138-141.

[97] Cf. ibid., 140.

space, the flow into the adjacent possible can be said to *make* the space in which it functions, expanding from the existing conditions. This shines a completely different light than the usual metaphysical or quasi-metaphysical explanations of the possible: possibility itself is emergent. The system is non-integrable as well as truly open. Kauffman defines this as an "open texture" emphasising at the same time the intrinsic and inevitable roughness of the present.[98] The logic on the base of which pre-adaptations expand into the adjacent possible expresses a finitude more radical than that of deterministic chaos, moreover one that refers even less to the notion of limit (or counter-actualisation) for its validity. In this light, the speculative approach to ontology introduced by Deleuze, must be taken not with care but in the most radical possible way, secularising the return of difference by pointing to the openness of incompleteness. Indeed the fact that the space of the possible does not pre-exist the emergence of the possibilities demands that speculation is freed from the virtual horizon as a pure potential waiting to become actualised and is grasped instead as a dynamic form of incompleteness.

This passage from actual to actual is of crucial importance in the articulation of positive finitude that the thesis puts forth with the concept of dimensionality. This actual and present logic of possibility, not only reflects the non-integrability that was seen in Chapter 2, but most importantly shows how aesthetics as the surface of the present is fully autonomous in the construction and expression of its configurations. That which is present does not owe its existence or its distribution to anything but its own evolution.

In this light, Kauffmann's possibility also differs from the interpretation proposed by Manuel DeLanda, where emergence takes place in a space where possibilities appear in a certain sense already pre-laid. DeLanda associates possibility with the Deleuzean virtual and emergence with the heterogeneous encounters described by the logic of the rhizome.[99] However, this move forces him to foreclose the innovation of emergence for something

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[98] Cf. Kauffman, *Reinventing the Sacred*, 4.

[99] Cf. Manuel DeLanda, " Emergence in History," in *Philosophy and Simulation: The Emergence of Synthetic Reason*, (London: Continuum, 2011), 1-6.

much more ontologically acceptable, by setting up a space in which emergence would appear. Such space of possibility in which emergence would take place is exemplified with the potential ability to cut attributed to a knife. However, instead of thinking that the knife's sharpness linked to the softness of an object makes the possibility of cutting emerge, DeLanda speaks of actualisation: he writes of a possibility "to cut" and a possibility "to be cut" as if these were pre-existing and circulating separately, in terms that are ambiguously tangent to the *abstract*. Presenting possibility in such active and passive forms, introduces a complementarity in the heterogeneity of the terms that voids emergence, since it presupposes or projects a space of possibility (or plane of immanence) that retains all the a priori properties of the metaphysical absolute. That is, pre-lays the dimensions along which the present can unfold as fixed tracks; it lays out the space of the possible as an a priori receptacle. The danger implicit in this interpretation becomes evident when these contingent possibilities are pushed to the limit: as a 'possibility to x', or *possibility* tout-court. That is, the possibility to be, or Being per se as the *univocal* Being that is said in the same way for all instances of existence or beings.[100] In fact, following this approach, one would be delivered back onto Heidegger's lap (the inescapable onto-theology). This is the problem that one inherits from Deleuze when reaching out to the ontological virtual (difference) without care. In fact, thinking of a space of possibility as virtual inevitably leads to quasi-metaphysical solutions for the logic of sense. Without grasping the import of this difference, emergence loses its a-causal logic of coherence and becomes captured again by reductionist ontology. In fact, DeLanda's interpretation of emergence presents possibility as a quasi-lack and ignores the fundamental aspect of Deleuzean speculation, which is to be oriented forward toward implementations and interpretations yet to come.

To grasp this speculation, as the logic of possibility, truly outside any onto-theo-logical paradigm, the possible must be grasped as emerging as much as its products emerge. That is, in order to grasp the creativity of possibility speculation must be completely

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[100] Cf. Deleuze, "Twenty-Fifth Series of Univocity," in *The Logic of Sense*, 203-207.

secularised so that this possibility can show how it acts as the method/logic of making sense, in biology, history or indeed contemporary art.

Possibility, Space and Incompleteness - The notion of adjacent possible marks a point of intersection where several concepts interact and the finitude of the present can be grasped as both positive and open. On the one hand, the logic of adjacent possibility escapes and denies the possibility to deduce or predict the emergence of new functions.[101] The emergence of new organisations or functions reflects Gödel's undecidable propositions, semantically meaningful and grammatically legal, while not deducible from a set of a priori axioms (in this case physics).[102] On the other, Kauffman points out that it is not only a new function that emerges beyond the perimeter of deduction, but the relevance this function develops is an equally emergent feature, which cannot be deduced (i.e.: there was no need for floating at different depths until the flotation bladder appeared making floating possible). The new emerged function is equal to its properties elevated to the power of its relevance in the new environment. Both emerge and expand the space of existence, increasing the network dimensions. The multiplication of properties and relevance constitutes heterogeneous and incommensurable associations (from the point of view of a priori definitions), which generate coherence outside a linear synthesis; one that brings together parts that cannot be said to be complementary (as instead they seemed to be for DeLanda). As will be seen later in the chapter, this heterogeneity is one of the strongest indicators of the affinity of the logic of adjacent possibility to rhizomatic emergence.

In this light, moving from conditions rather than from concepts to explain the organisation of the present (aesthetic) leads to a form of progressive emergence both non compressible and not tangent to the horizon of difference; that is, to a process that cannot fit in the purely ontological passage from disorder to order and vice versa, as it takes place with the vector of actualisation and counter-actualisation. Kauffmann shows how the

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[101] Cf. Kauffman, *Reinventing the Sacred*, 162.

[102] Kauffman refers explicitly to Gödel's incompleteness for this non-deducibility of the present. Cf. Kauffman, *Reinventing the Sacred*, 22, 135, 174-175.

adjacent possible acts without the need to postulate a totality or a finite boundary. In fact the problem should be reversed, the adjacent possible is the engine that generates an open present, order emerges because the present is open. The emergence of organic building blocks such as proteins, provides a useful example: given the extremely high number of possible combinations of their components, if the selection had progressed through a systematic process of trial and exclusion based on testing each single possible configuration and selecting only the few that exist (an ergodic process), the process would have taken infinitely longer than the life of the existing universe.[103] In fact, not only "the set that actually exists is a tiny subset of the possible," but also the entirety of the set is not given and its idea is as arbitrary a totalisation as Hamilton's image of dynamics (as it was seen in Chapter 2).[104] In other words, proteins have emerged outside a deductive process that would act within a Hilbertian space, which from a set of given axioms and their inference rules would have hoped to deduce a priori all possible non-contradictory theorems, or paths of evolution. It is here that Kauffman summons Gödel's incompleteness, which shattered such smooth space comprehensible a priori. As was seen, the solution Kauffman proposes is the acceleration taking place in collectively autocatalytic processes. However, this is also where adjacent possibility, as well as Prigogine and Stengers' non-integrability, go further than the problem of undecidability encountered in mathematics, showing that the impossibility of such a priori space imposes a finitude to the existent present, which in turn is the condition of its possibility. This is a pivotal point for the reconceptualisation of possibility after complexity and its impact on the notion of aesthetics:

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[103] Ergodic defines a space whose points or configurations are systematically visited by the evolution of the system. Nonergodic is the behaviour of systems whose cycles are infinitely long. This was already seen regarding Poincaré and Gribbin's phase space limit to infinite measurement in chapter two. Kauffman here exemplifies this concept with the calculation of probabilities involved in the creation of all possible proteins from their amino acid components: there exist 20 kinds of amino acids; to generate a string of "200" amino acids (which is a conservative figure for general proteins range from "300" to "several thousand" - he writes) the possible configuration is 20 elevated to the power of 200 (or 10^{260}). As in the argument presented by Gribbin about the returning cycles in phase space, Kauffman concludes that a time longer than the life of the existing universe would be needed to systematically (linearly) explore all the configurations in the space laid out a priori by the number of amino acids and the lengths of the strings, which is an evident paradox. Cf. Kauffman, "The Nonergodic Universe," in *Reinventing the Sacred*, 120-128.

[104] Cf. Ibid., 122-123.

on the one hand, as it is shown here, finitude via the logic of the adjacent possibility acts as the conditions for contingent evolution and history; on the other, as will be seen later, this adjacent possibility brings the greatest challenge to ontology to date, because its finitude is also the very condition of existence. The intersection of incompleteness and relevance at play in the adjacent possible moves the logic of possibility even further away from the two traditional prongs of ontology (linear reductionism ontology and the passage to the limit), and from their insistence on the quest for the ultimate.

In this light, the present must be grasped as a surface that is neither a horizon nor an edge of the organism/organisation. It does not separate and does not connect. In fact, it is a finite and yet open organisation. The present is not the presence of something else, it is a given not compressible into a pure form or givenness, it can only be represented by its entire history and with the interrelations that make its surface. Prigogine and Stengers' early work on thermodynamic irreversibility complements Kauffman's autocatalytic sets theory. Incompleteness is here interpreted as dynamic and the surface of the present open. Moreover, this temporal limit acquires new relevance with Kauffman's theory of collectively autocatalytic sets. Rather than testing linearly the deducibility of all possible combinations of a given set of initial axioms, the system has moved into its adjacent possible at increasing speed, converging onto one unique but not necessary organisation. This convergence –it will be seen- corresponds to Leibniz's notion of compossibility, which neither moves inside a space of deducible possibility nor acts with reference to a virtual horizon. In fact, the adjacent possible names a logic where the new emerges as a singularity, and each time anew (heterogeneously and locally). Each invasion of the niches generated by adjacent possibility is unique, Kauffman writes, it cannot be generalised into one total or transcendental event of possibility, which instead is at the root of deleuzean ontology.[105]

This is a point of crucial importance, because while it frees possibility from any metaphysical base, it also links it directly to time. Advancing into the adjacent possible –

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[105] Cf. Kauffman, *Reinventing the Sacred*, 123; and Deleuze, "Twenty-first Series of the Event," in *The Logic of Sense*, 169-175.

Kauffman writes- "is an arrow of time.'[106] The network grows into the adjacent possible it generates locally.[107] This retroactive synthesis of the pre-adaptations generates functions that do not pre-exist their emergence. They cannot be thought of as actualising a virtual function (unless one is prepared to revert to metaphysical idealisations such as the demons of dynamics or Leibniz's divine mind). The present is unique, a singularity, the product (the producing product, in fact) of history.

Ontological emergence, body and organs - Kauffman repeatedly stresses that the logic of emergence is not in contradiction with the laws of physics and yet cannot be explained with them: emergence is "partially lawless". The "evolution of the biosphere is partially beyond scientific law," its path "cannot be finitely prestated," it is a radical creativity which builds on the ground of the law but generates organisations that the existing law cannot explain; life and the present are partially lawless.[108] This partial lawlessness is a delicate concept. It should not be allowed to name the emergence of an epi-phenomenon without intrinsic legitimacy. Isabelle Stengers had individuated this risk in neo-Darwinist elaborations of emergence, such as those of Monod or Dawkins. She pointed out how their response to the vitalism paradigm proposes a mechanistic interpretation of the emergence of life, where the rejection of an ultimate finality yields to internal or micro-finalities, which dictate the macroscopic phenomena as their effect.[109] This amounts to rejecting determinism as the rule of one overall cause only to reproduce the same logic via the reductionism to the blind repetition of the law (the "blind watchmaker" of Dawkins or the teleonomy replacing teleology in Monod).[110] This in fact would lead to the view that reduces life to nothing but particles in motion – as Kauffman warned. These interpretations would in practice deny emergence, implicitly attributing the lawlessness of the present to the inability

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[106] Cf. Kauffman, *Reinventing the Sacred*, 123.

[107] Cf. Ibid., 163.

[108] Cf. Kauffman, *Reinventing the Sacred*, *35-37,* 130.

[109] Cf. Stengers, "The Question of Emergence," in *Cosmopolitics, Vol.2*, 207-218.

[110] Cf. Richard Dawkins, *The Blind Watchmaker* (London: Penguin, 2006); Jacques Monod, *Chance and Necessity*.

of a weak contingent knowledge to calculate the entire cause-effect chain; a subjective indeterminism, still vulnerable to the gods and demons of the classic paradigm of the conservation of sufficient reason. Contrary to this view, the position that Stengers and Kauffman share is that emergence concerns a "living whole" whose development is non-integrable and -most importantly- qualitative.[111] In so doing, Kauffman emphasises once again the significance of incompleteness in self-organisation processes, and reiterates the claim that evolution cannot be reduced simply to processes of selection, which would lead to interpretations along deterministic lines. In fact, the spontaneous convergence of self-organisation reflects an open element of creativity, which can only be articulated via augmented causality.

Stengers will turn this question around: emergence –she writes- should be addressed as a "problem" concerning its very possibility; that is, in terms of the terrain on which a coherent novelty can appear and repeat.[112] She will seek a solution in the light of the passage to the limit where the properties of matter or of the network tend to infinity or zero. This is however rather delicate since Stengers' proposition seems to point to an ontologisation of such a limit as an ultimate, a Deleuzean plane of immanence or difference as the horizon, conflating the limit of one contingent property with the ontological limit onto which all properties would vanish. In the regime of adjacent possibility instead the limit is the specific and local limit of the properties of matter, the historical organisation and distribution of the network in the present, both of which are finite without, for this, being bound by an ultimate ontological horizon. In fact, this limit should be thought of as a hinge in a heterogeneous continuity of different properties and forms of organisation, which coexist, perhaps overlap and intersect, but are not cut by an abyss that would separate them.

In this light, the present appears as a synthetic singularity; that is, it is both non-reducible and yet caused. It is the last link in a chain of irreversible augmented causality, itself the product of previous singularities. This underlines how possibility itself is emergent,

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[111] Cf. Stengers, *Cosmopolitics*, Vol.2, 212.
[112] Cf. Stengers, *Cosmopolitics*, Vol.2, 225-6.

rather than the linear product of deterministic chains or the actualisation of a virtual identity. Openness permits becoming; yet, it does not contain the possibilities of such becoming and it does not make it in any way necessary since openness is not something in itself. To grasp this truly outside any onto-theo-logical paradigm, the creativity of possibility must be understood as emerging as much as its products emerge. Only in this sense can the Deleuzean interpretation of the transcendental as speculative be accepted without drifting inexorably towards a metaphysics in disguise. In fact, it is paramount to avoid turning this openness into a metaphysical solution; to identify it, that is, with an image of chance that acts as a quasi-cause, thereby voiding openness of its fundamental trait of not being or acting as reason. While, language may need to name this absence of reason 'chance' in order to implement it into sentences, thought is not allowed to build an ontological structure upon it - while at the same time pretending that such absence has not been surreptitiously turned into a cause. As will be seen, this is the same problem one encounters in the "principle of unreason" put forth by Meillassoux.[113] Meillassoux does not hide his intentions and claims for this principle the status of a new absolute. Nevertheless, by being something it cannot be unreason.

Deleuze and Guattari's metaphor of the rhizome appears inspired by the logic stemming from evolution and thereby incorporates these partially lawless adaptations, as well as the non-deducibility of the biosphere from the laws of physics and its intrinsic creativity.[114] The very idea of a logic of difference and repetition, as in Deleuze's work, reflects a Darwinian process of random differentiation and of reproduction of the differences. Speculation treats concepts as ontological emergence on the basis of "causal consequences," which confirm the coherence of real entities. These would not last without repetition, iteration and reproduction.[115] However, it is important to clarify that the

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[113] Cf. Quentin Meillassoux, *After Finitude.*

[114] Cf. Gilles Deleuze and Felix Guattari, "Introduction: The Rhizome," in *A Thousand Plateaus*, *Capitalism and Schizophrenia*, trans. Brian Massumi (Minneapolis, MN: University of Minnesota Press, 1987), 3-25.

[115] Cf. Kauffman, "The Nonreducibility of Biology to Physics," in *Reinventing the Sacred*, 31-43; and Deleuze, *Difference and Repetition*, in particular "The Image of Thought," 164-213.

heterogeneity with which such pre-adaptations find unpredictable but coherent consequences, and thereby become installed as organs, does not correspond to the move of territorialisation and deterritorialisation that Deleuze and Guattari present. That is, coherence does not follow a counter-actualising vector hinging on the plane of immanence as pure potentiality. It is instead finite. Incompleteness is again at play here, it states an impossibility that makes the process univocal and allows creativity without the need of a pure source of potentiality. Axioms exist and set the boundary conditions of matter and thought, they are necessary and yet not sufficient for the organisation of the present. The speculation that Deleuze introduces is as powerful a concept as it delicate. Emerged organs are open in so far as they are not entirely deducible or reducible. Yet, this openness is not a property per se, it cannot be abstracted or projected as the limit, thus constituting an ontological ultimate (or the "body without organs" introduced in *Anti-Oedipus*).[116] In fact, an organ –to remain within Kauffman's argument- comes to be open only when it finds ways to combine with the environment (the heterogeneous principle of connection of the rhizome); otherwise it remains what is it (in fact, it remains all that is there is without the possibility of thinking what is not there, but may or ought to be there in order to form a whole).[117]

At this point it becomes evident how the organisation of the present (pre-adaptation) constitutes a finite pattern whose shape and rhythm can be interpreted and implemented in multiple but finite number of ways. That is, adjacent possibility while explaining a-causal or non a priori heterogeneous associations does not reflect the notion of Body Without Organs that Deleuze and Guattari had formulated. In *Anti-Oedipus* this body without organs or plane of immanence is an unstructured existence, the potentiality at the transcendental limit upon which events organise and organs indeed emerge. This is the opposite of Kauffman's proposition. The adjacent possible does not concern the ultimate, ground or limit, but the

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[116] Cf. Gilles Deleuze and Felix Guattari, *Anti-Oedipus: Capitalism and Schizophrenia*, trans. Robert Hurley, Mark Seem, and Helen R. Lane (Minneapolis, MN: University of Minnesota Press, 2000).

[117] That is the expansion of the adjacent possible has nothing to do with dialectical sublation. Cf. Georg Wilhelm Friedrich Hegel, "Preface: On Scientific Cognition," *The Phenomenology of Spirit*, trans. A.V. Miller (Oxford: Oxford University Press, 1977), 1-45, see in particular the claim "The True is the whole" in §20.

logic of multiplication and maximisation of organisation and information in the present. Obviously this does not mean that the evolutionary approach Kauffman follows excludes an initial moment or chronological origin. The difference, as was shown in Chapter 2, is that this origin cannot be considered relevant for the present in the same way as ontology instead would like to present it. The irreducibility of the present, or non-integrability, creates an insurmountable distance whose negotiation can only take place temporally, through the same dissipation of energy and increase of information that were encountered on the way to the present; the entropy barrier that Prigogine had formulated in *Order Out of Chaos* blocks any linear reversal as much as any tangent exchange with the ultimate. This has consequences that reach further than a passing remark to the argument presented. The body without organs has provided a useful metaphor for the plane of immanence, and has often been interpreted as an alternative to dialectical materialism.[118] In sharp contrast with this, the notion of dimensionality that the thesis proposes aims at an alternative interpretation of materialism that is neither dialectic nor founded on a virtual ontology such as the Deleuzean option. As will be seen in Chapter 4, this is the radical materiality of genetic dimensions.

The form of coherence that takes place partially beyond the law is not only not expanding along a priori coordinates that reflect the Euclidean paradigm, but is also not hinging its finite order onto a tangent transcendental limit, be it Being or returning difference. Rejecting a linear trajectory stemming from identity (or N+1), Deleuze and Guattari articulate the extension of the dimensions of the rhizome as a differential, the contingent actualisation diverging from the pure potentiality of the limit, or "N-1."[119] While the relation to a retroactively generated identity plays a role in the regime of adjacent possibility, the retroactive coherence is historical and its implementation local. New associations are not passing to the limit, as the transcendental and forever diverging

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[118] Cf. for instance Cheah Pheng "Non-Dialectical Materialism,' in, *New Materialisms*: Ontology, Agency, and Politics, ed. Diana Coole and Samantha Frost (Durham: Duke University Press, 2010), 70-91.

[119] Supra: In Chapter 4 it will be explained how the one and the zero, the ground-idea and the limit-horizon, are fictions of the present, parts of its pattern.

horizon of the ontological ultimate. In fact, and this is absolutely crucial in the reconceptualisation of possibility proposed in the thesis, *it is not the unity of Being at the limit that is transcendental, but rather the organisation of the present*. It is not the idea, that is, which reveals and conceals itself as a receding horizon, as Heidegger's Being which influences the postmodern version of ontology that Deleuze proposes, rather it is the openness of the finite organisation of the present (this present here and now) that makes the present *metastable*; that is, coherent as long as the boundary conditions last, but open to change. This is not because it lacks identity, but because its identity keeps emerging.

If this still seems quite similar to the virtual ontology that Deleuze proposes, it must be kept in mind that Deleuze seeks a logic that can allow speaking of ideas, that is ontological identity, although free from a priori obligations. However, speculation as he proposes it, still moves in the event-space of idealised identity, albeit a reverted one – hence the paradox of an image without object, or present without concept, as a simulacrum. In contrast to this, the argument that emerges from Prigogine, Mandelbrot, and Kauffman, is that the ontological structure of concept and object no longer speaks to the problems encountered. In other words, seeking the givenness of the given will always and inevitably lead to seek the ultimate, even if such givenness is recast as difference. Instead, the elaboration of pre-adaptations that Kauffman puts forward proposes a form of incompleteness that is intrinsically dynamic, finite and open. A logic that is not in contradiction with fundamental physics, but at the same time cannot be deduced from it as if it provided the axioms of existence.[120] The surface of the biosphere for Kauffman is teeming with life because it is alive, creativity as much as sacredness belong to it. That is, it

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[120] Supra: As it will be seen later in the chapter, this form of incompleteness expresses an intrinsic temporal logic that is developed by Gregory Chaitin through the exploration the possibility of achieving compressible definitions (simplicity) in relation to the problem of reducing complex distributions to a priori simple descriptions discussed by Leibniz. Cf. Chaitin, *MetaMaths!* and Gregory Chaitin, "Leibniz Complexity and Incompleteness," streaming video, accessed June 6, 2016, http://www.quizover.com/oer/course/leibniz-complexity-and-incompleteness-by-gregory-chaitin-videolectures. Cf. also Gottfried Wilhelm Leibniz, "Discourse on Metaphysics," in *Discourse on Metaphysics and Other Writings*, trans. Robert Latta and George R. Montgomery, ed. Peter Loptson, (Toronto: Broadview, 2012), 57-101, in particular §5-6.

is complex, its cause is a continuously augmented causality, and it would lose its identity if reduced to origins or pushed to the limit.

Univocity - The partial legality and non-deducibility of self-organisation shows that the adjacent possible names a creativity that at the same time acts as a univocal vector of becoming, both reflecting Prigogine's chrono-logical irreversibility and underlining the distance between this creativity and pure ontological possibility. In fact, it points in the opposite direction: in the work of the adjacent possible incompleteness leaves room for a present whose finitude is intrinsically rough because it can only be historical and contingent. Kauffman calls this an "open texture," a pattern produced by history but not led by finality or concept.[121] This points to a regime quite similar to the logic of heterogeneous associations found in the rhizome; one whose evolving pattern constitutes the dimensions of possibility. However, the Deleuzean event is embedded in a different kind of univocity, which instead still has strong reductionist echoes:

> "The univocity of Being signifies that Being is Voice that it is said, and it is said in one and the same "sense" of everything about which it is said. That of which it is said is not at all the same, but Being is the same for everything about which it is said. It occurs therefore as a unique event for everything that happens to the most diverse things, *Eventum tantum* for all events, the ultimate form for all of the forms which remain disjointed in it, […] Being is the unique event in which all events communicate with one another."[122]

This univocity of Being introduced by Deleuze is in fact an ontological common denominator. It expresses the transcendental continuity on which all events are hinged, the event in whose space all events can happen; that is, the very *possibility* of being and existence. Actualisation and counter-actualisation circle in this space. Indeed, Deleuze's counter-actualisation appears to violate the prohibition of non-integrability and move freely up and down the line of entropy. Instead, univocity in the light of incompleteness -as

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[121] Cf. Kauffman, *Reinventing the Sacred*, 4.
[122] Cf. Deleuze, "Twenty-Fifth Series of Univocity," in *The Logic of Sense*, 203-207.

Kauffman presents it- is precisely bound by the pattern of its history, which determines its conditions but not the space in which this evolves. Indeed, the adjacent possible is a creative logic that marks the present not as an engine that transforms the future into the past, but as the progressive augmentation of the present. Therefore, the partial legality and the non-deducibility of the products of adjacent possibility must not be grasped as paradoxical. Or rather, they would be paradoxical if addressed on the base of a Euclidean or Hilbertian space paradigm, which constitutes the a priori stage on which events take place; they are not paradoxical instead, if they are thought of as an expanding network, which creates both new links and the points these join.

With Kauffman and Prigogine this univocity becomes irreversibility. This is not simply yet another name for Being as the ultimate of all beings, rather it is the peculiar ontological property of non-reducibility (or non-deducibility) of all things present. Finitude then constitutes a pattern that constrains evolution, yet not with controlling agency but passively offering a limited number of options as causes for change.

As will be seen, Kauffman positions this univocity as ontological emergence: a coming into existence legitimised on the base of the consequences rather than supported by causes. It acts as an *anchoring forward*, bringing to the fore political and ethical problems and well as epistemological and aesthetic questions as one continuous front of emergence into presence that speaks to the questions of *relevance* and *diffraction* raised by Stengers and Barad, rather than privileging a pure ontological vector and the hierarchy this implies. In this sense, the logic of adjacent possibility is in dialogue with Deleuze speculation, as a logic of emerging identity and also with the interpretation as creativity that Stengers makes of it. At the same time, it should be kept in mind that chance (or radical difference) for Deleuze raises individuation from the isotropic depths of pure difference. This is a movement of differentiation where chance acts as a "quasi-cause" in the process of individuation and historical actors embody the event.[123] Instead, the emergence proposed

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[123] Cf. Deleuze, "Difference in Itself," in *Difference and Repetition*, 36-89.

by Kauffman is not the pure emergence from the depths of difference, rather it is a move stemming from the continuous recombination of previous combinations on the surface of the present. It is rhizomatic, but does not stem or return to a plane of immanence as its source and limit. Indeed, it is the move from the historical to the historical, rather than the passage from the ontological to the contingent, or from the metaphysical to the historical.

Indeed, temporality for Deleuze is a *product* of the process of actualisation; time is the product of the event. While Prigogine, Stengers and Kauffman provide a dynamic interpretation of incompleteness where temporality/history is the *logic* of the process of actualisation, the logic that allows it and carries it; time is the logic of the event and produces presence. Here begins to appear a distinction between the ontological question *why something rather than nothing* and the aesthetic/epistemological question *how are things thus rather than otherwise*, based not on the hierarchy of necessity (identity) and contingency (sufficient reason), but on the relevance of finitude. This will be discussed in the last section of this chapter, nevertheless it is important to notice that the identification of possibility with finitude, and therefore the reconceptualisation of aesthetics as the logic of presence rather than the surface of identity, hinge on the prohibition raised by the entropy barrier to reduce or deduce the answer to the second question from the solution of the first.

The problem should be reframed. What is raised here, what is encountered and imposes itself, is not the question of the origin of all things, as an ontological big bang.[124] In fact, this is precisely the question that has lost relevance for what concerns the logic of sense in the present, because the present (the here and now) cannot be reduced to it without being destroyed and therefore without losing all its relevance as well. What will come into play instead is a notion of non-linear genealogy; one made of accelerations through resonances and increases in causation, which the present carries with itself (a

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[124] The expression "origin of all things" refers to a short text of Leibniz from 1697, and is introduced here preparing the terrain for a reframing of the role causality plays in the determination of the possible, in the light of the logic of compossibility that Leibniz had formulated. Cf. Gottfried Wilhelm Leibniz, "On the Ultimate Origination of Things," in *The Shorter Leibniz Texts*, ed. and trans. Lloyd Strickland (London: Continuum, 2006), 31-37.

complex sufficient reason).[125] The present reality is always and only augmented reality. Its synthesis is not linear and, therefore, the possibilities it expresses are local and heterogeneous, without this heterogeneity being totalised and projected as the ultimate property of beings (or univocity of Being). That is, it is aesthetics and not ontological identity that determines/dictates possibility.

In this light, the univocity of emergence constitutes an irreversible creative process. The space of possibility expands in the present; the present expands. Kauffman manages to offer a positive version of the negative definition of incompleteness. This non-deducibility happens outside the consistent space laid out by any fundamental. It is an expansion of the space of the possible, where present is the unit of measure. The emergence of possibility does not take place but rather makes place, or indeed it makes sense. The present is richer in information than the past, and produces more information, which becomes the next present (<1<).[126] This breaks the commensurable economy of sufficient reason for a regime of augmented causality, as it was discussed in Chapter 2. However it must be clear that this is not an argument for immanence. The ultimate (limit or ground) is not absorbed into the present, in fact, precisely the opposite. It is the incompleteness of the present that makes it dynamic. It is this open finitude that allows fluctuations in the existing organisation to create new possibilities for its evolution, not on the ground of a reason but precisely because there is no reason.

With this, it is possible to begin looking past the opposition that Stengers found between ontological possibility (virtual) and deterministic probability. Kauffman has shown that adjacent possibility can generate an organisation, which is coherent in its own right, without being autonomous or linearly caused. Finitude has turned inside out the concept of possibility, its space is the present, its coherence produced by a retroactive synthesis.

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[125] Supra: The notion of genealogy concerns the temporal aspect of dimensionality. This will be discussed in Chapter 4.

[126] Cf. Kauffman, "The Evolution of the Economy," in *Reinventing the Sacred*, 150-176.

Heterogeneity and the Adjacent Possible - In the light of the augmented causality just exposed, the notion of adjacent possible leads to an alternative interpretation of the rhizome as a network of augmented reality; a organisation that expands itself rather than expanding into something. This alternative logic moves away from the regime of actualisation and counter-actualisation, which is at the core of Deleuze and Guattari's ontology, while retaining the heterogeneity that characterises the associations that give rise to the rhizome. To be clear: an emerged present cannot be reduced (non-integrability bars it). Only the entire history and extension of the system is sufficient to describe the system. The logic of the present is therefore a surface, yet this surface is a peculiar kind of rhizome because the randomness that it encounters as a metastable system is not an ontological limit (as it was seen in Chapter 2, chaos cannot be unified into the liminal idealisation of bifurcations but by an arbitrary generalisation). The rhizome is *flat*, claim Deleuze and Guattari, not structured by vertical roots reaching to identity.[127] However, to abandon the recurrent spatialised image of ontology that accompanies the a priori, the chrono-logical irreversibility of emergence must be acknowledged in full. The vanishing point on which hinge the lines of flight that deterritorialise the rhizome's organisations cannot be posed or thought as tangent to the order of the present.

It is worth hearing again Prigogine's warning against a metaphysical interpretation of chance. In a conversation with Alvin Toffler related in the Foreword to *Order out of Chaos*, Prigogine recommends hesitating in front of the "role chance plays at or near the point of bifurcation, after which deterministic processes take over once more," till chance raises again at the next bifurcation. Toffler sees a risk of embedding chance in a deterministic framework, assimilating it to a form of causality albeit without identity. To which Prigogine replies that this interpretation would be correct but for one caveat: "we can never know when the next bifurcation will arise."[128] That is, chance would make a very unreliable and poor cause, precisely because it is the result of openness and not something in itself. It

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[127] Cf. Deleuze and Guattari, "The Rhizome," in *A Thousand Plateaus*, 3-25.

[128] Cf. Alvin Toffler "Foreword: Science and Change," in Prigogine and Stengers, *Order out of Chaos*, XI-XXVI.

should be thought as a moment of opening rather than as something intervening to unhinge the deterministic order of things. In this regard, Deleuze quasi-cause (difference) is vulnerable to an interpretation of chance as a nameless sufficient reason. Indeed, what would seem an "ontology of chance" is in fact sufficient reason reduced to is bare structure: the need for a reason separated from the event.[129] While Nietzsche had envisaged difference as an eternal return that would free thought and morals from the authority of a unified totality, favouring change over identity, Deleuze re-captures this within the existing framework of sufficient reason.[130] With this move, openness shifts from being an attribute of the present to be a noun naming something in itself (difference), and the emergence of possibility is not entirely freed from metaphysics. If a way to clear this hurdle can be found, the rhizome would still have a lot to offer for the articulation of the logic of sense.

On rhizome heterogeneity and the Adjacent Possible - Heterogeneous connections, the first and the second principles of rhizomatic logic, do at first seem to reflect the notion of adjacent possibility as the new selected function of a secondary function, which associated to a new environment develops new causal consequences that generate new coherence.[131] However, given the quasi-metaphysical nature of counter-actualisation in the metaphor of the rhizome, some discrepancies must be pointed out.

The flatness of the rhizome is not just a visual metaphor. While it abandons the arboreal structure that develops the principle of non-contradiction through roots, trunk and branches, it also leaves by the wayside the relevance of the chrono-logical processes that generate an irreducible distance between the present and the transcendental horizon. It is instead necessary to retain the history associated with these processes, allowing their contingent genealogies to come to the fore, rather than entrusting sense to the work pure

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[129] This interpretation of Deleuze ontology and Deleuze and Guattari *Body Without Organs* as matter free from the negative opposition and the mediating process with the idea precisely overlooks the problem of entrusting difference with the role of a disembodied force, or indeed a cause. Cf. Cheah Pheng "Non-Dialectical Materialism,' in, *New Materialisms*, 70-91.

[130] Cf. Friedrich Nietzsche, *The Gay Science, With a Prelude in Rhymes and an Appendix of Songs*, ed. and trans. Walter Kaufmann (New York, Vintage Books, 1974).

[131] Cf. Deleuze and Guattari, "The Rhizome," in *A Thousand Plateaus*, 6-25.

lines of flight that aim at a disembodied ontology. Deleuze and Guattari insist that the rhizome is "anti-genealogical."[132] It will be seen in Chapter 4 how these are historical genealogies inspired by Foucault, rather than the linear deduction from identity that Deleuze and Guattari want to distance themselves from.[133] Equally delicate is the possibility to connect "any point to any other point" in the rhizome. This presents a completely fluid and open structure; one, however, that deprives the irreversibility of chronological development of the network of any particular relevance. While the emergence of adjacent possibilities also is intrinsically heterogeneous, it does not respond to this open connectivity, or open possibility. On the contrary, in Kauffman's proposal, possibility is adjacent to the present; it is its next and simplest functionality. It is a generator of sense that the existing organisation can develop iterating the new contingent forms of coherence that have emerged; it cannot be decomposed. In other words, possibility is limited by the irreducible organisation of the present; yet as will be seen this is a positive limit, which provides the very condition of the possible. In this light, genealogies name processes of historical finitude. Rhizomatic logic does indeed establish connections between chains of organisation, or semantic chains, yet these are only local not diachronic.[134] In this sense, the contingent open finitude of the present introduces a much more radical logic than the emerging individuation which can be developed by a purely ontological speculative move, because it is locked in its contingent history. The rejection of genealogies in the rhizome's logic refers to the linear history stemming from a point of origin and developing on the base of non-contradiction; that is, a linear causality that reflects the conservation of identity via the economy of sufficient reason. In Kauffman's argument instead, genealogies are not rescindable from the emerging but contingent possibility and, rather than expressing the conservation of identity, they are the product of the continuity of coherence and retain its variations over time. It is

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[132] Cf. Ibid., 10.

[133] Cf. Michel Foucault, *The Archaeology of Knowledge*, trans. Tavistok Publications (London: Routledge, 2004). Nietzsche also provides an essential key into this process based emergence of coherence, Cf. Friedrich Nietzsche, *Hecce Homo: How One Becomes What One i*s, trans. Thomas Wayne (New York, NY: Algora Publishing, 2004).

[134] Cf. Deleuze and Guattari, "The Rhizome", in *A Thousand Plateaus*, 7.

on the base of this continuity of coherence within complex systems that the heterogeneous connections of the rhizome can provide a valid alternative for a priori identity.

The deterritorialisation brought by the line of flight, or to follow Kauffman, the flow into the adjacent possible, is in fact only a reterritorialisation of previous territories, which do not lose their functions through a transition to the limit. That is, organisations do not become deterritorialised or counter-actualised in the heterogeneous connections taking place in the rhizome. Indeed, the difference that comes into play for heterogeneous associations ruled by Kauffman's emerging possibility is instead one of relevance. That is, the question that must be asked is how far back or forward the relevance can be re/traced and when instead forms of territorialisation no longer have causal consequences for the sense of the present and the questions at stake. The temporal windows that described the limits of non-integrability for Ljapunov return here to address and explain the extension of this relevance, that is, the extent to which a fact has causal consequences and a decision matters. As will be seen in the next section, this relevance is a problem shared by all creative processes, including artistic practices.[135] Art is in fact particularly well suited to express how far the meaning of the speculative approach to sense reaches. This goes well beyond the immediate but reductive application as an alternative to the idealising paradigm that individuates abstract concepts moving from empirical data, to include acts of decision that may have an impact on the organisation of the world of sense. In the light of non-integrability, it is no longer possible to think of the plane of immanence, or pure difference, as directly meaningful and relevant for the present and the sense that organises it. In fact, the flatness of the rhizome is not only the visual metaphor that Deleuze and Guattari oppose to the image of the vertical depth of what they call "arboreal" logic, or linear reductionism. Rather -one can see now- it must be understood as reflecting the radical

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[135] Supra: Obviously this moves away from an image and understanding of art as something grounded in a medium. This will be discussed in Chapter 4, recasting artistic operations as interventions of diffraction – to begin positioning Karen Barad's concept in a more precise manner in the argument of the thesis- rather than creation ex nihilo.

finitude and locality of the logic of the adjacent possible; that is, the emergence of possibility from the specific configuration of the present and its functions and structures.

The genealogies of the adjacent possible by intersecting, interrupting, becoming marginalised or reintegrated as the rhizome postulates, present a univocity that –as was seen- is not the same as the geometry where organisation is tangent to difference, as presented by Deleuze and Guattari's deterritorialisation. Deleuze had auspicated a "geometry of sufficient reason" to replace the a priori paradigm of Euclidean geometry that defines the image of thought.[136] However, even this geometry would result in a hollow attempt if sufficient reason is still allowed to have a direct grasp on the present –even when its cause is disembodied and refashioned as chance or difference. Indeed, this direct influence would deny the complexity of history and flatten the distance that the non-deducibility of the information circulating in the present has generated through the process of emergence. Instead the counter-actualisation vector as an ontological move, where order is tangent to difference, resets the present to zero and erases the importance of such genealogies. Therefore, sufficient reason maintains a direct and continuous control on the present, although through an incommensurable jump. This instead is not the case with complex sufficient reason. Augmented causality makes the present irreducible to axioms as much as barring its ontological deterritorialisation. The univocity of the network generated by the adjacent possible is a radical form of irreversibility that neither permits retracing the path to the origin, nor allows the existing pattern to merge into the limit conditions without a renegotiation that would require as much expenditure as the process that generated it. It is strictly finite.

The flow of the adjacent possible is in this sense the engine of the augmented causality introduced in Chapter 2. Moreover, it is heterogeneity that provides the conditions, the material, and the logic for the creativity of the adjacent possibility.[137] Like the rhizome,

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[136] Cf. Deleuze, *Difference and Repetition*, 201.

[137] Explaining the self-organising creativity of the biosphere without recurring to an external design is Kauffman's main concern. Indeed, Kauffman's appreciation for the self-organising creativity of the biosphere is

this self-organisation does not respond to any a priori image.[138] Yet, unlike the rhizome, rather than being an "anti-genealogy" or an anti-teleology, as Deleuze and Guattari claim, adjacent possibility is in fact more radical. It is an *open* logic that defies all ontological images. The line of flight that leads to deterritorialisation is presented as a rupture that points to the ontological limit as the a-signifying horizon. However, in the light of Kauffman, the fact that each new expansion, or new generation of possibility, is heterogeneous amounts to a "rupture" that cannot be said to be "a-signifying" in the sense of undoing the previous function.[139] In fact, rather than the interruption of one order, adjacent possibility is the generative process of new heterogeneous organisations, compatible but incommensurable with the previous order and identity. The possible, therefore, emerges in the most radical sense. It does not take place into a space that pre-exists it and in which it would move, rather it expands the existing space with its emergence. This is not the returning to a virtual image of the present within which possibility would move. What makes it stick, what makes it emerge ontologically, is the possibility of continuing its repetitions (reproduction) and generate new questions. It is in this sense of forward relevance and retroactive synthesis that the speculation that Deleuze had proposed remains a valid concept for navigating the emergence of possibility.

This brings the argument to the key point: the rhizome is non-integrable; it cannot be reduced to the One, or to the multiple. The irreducibility of the rhizome excludes physical and logical axioms. It is a coherence that "is not composed of units but of dimensions;"[140] it emerges from the interplay of such dimensions as heterogeneous forms of organisation and repetition that circulate in the present. This shines a new light on Deleuze and Guattari's claim that the rhizome has no beginning or end and starts always and only from the

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such that the main thesis that *Reinventing the Sacred* proposes is the identification of evolution's creativity with the divine, rather than casting it as the expression of a divine design external to it.

[138] The fifth hand sixth principles of the rhizome state that the rhizome's coherence is "not amenable to a structure of generative model." Cf. Deleuze and Guattari, "The Rhizome", in *A Thousand Plateaus*, 11.

[139] Cf. "A-signifying rupture" as the fourth principle of the rhizomatic logic. Cf. Ibid., 9.

[140] Cf. Ibid., 22.

middle.[141] That is, this middle is not to be grasped as an origin that can be moved everywhere, splitting the chronological past and future with an infinitesimal ontological present. It must not be thought as the tangent point of contact between the here and now and the plane of immanence on the ontological horizon, but as the contingent and local heterogeneity of adjacent possibility. In fact, only in this sense the rhizome's transformations can be said constitute a metamorphosis of its nature, its unity and its logic rather than the expression of an external cause. This middle is equally distant from the One of totality as it is distant from the Zero of the limit. Its nomadic identity is not one that moves on a smooth plane of immanence, but one that changes heterogeneously from what it just was. In this sense it is not opposed to history.

As will be seen in the next chapter, genealogies do retain a fundamental importance for creativity, both in the broad sense of genetic and generative loops of repetition and in the sense of intrinsic creativity. Only thus, genealogies will no longer be the Hegelian linear development stemming from one point, but articulate and repeat the evolution and the history of changes.

3.4 The Compossibility Engine or How Things Cannot be Otherwise

In the light of what has been discussed so far, it is important to clarify how finitude dictates the mechanics of possibility acting as the self-constrained pattern of the present rather than as an abstract principle. This is essential in order to understand how finitude is *positive* rather than an external limitation and possibility does not need a priori or transcendental concepts to justify its creative logic.

Isabelle Stengers had laid out the problem raised by complexity as a challenge to the linearity of sufficient reason that supports determinism in scientific reasoning, and had indentified the epistemological roots of this paradigm with the conservation of causes and

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[141] Cf. Ibid., 22.

effects defended by Leibniz.[142] As was seen in Chapter 2, the problem at stake is not the rejection of causality altogether, but rather exiting a totalising image of ontology through the articulation of a form of augmented causality, or complex sufficient reason, which is non-linear, and follows local and heterogeneous rules. To explain how the mechanics of the possible constitutes a logic, rather than just an empirical description, this section will look at the theory of *compossibility* put forward by Leibniz, in order to position the reconceptualisation of possibility in relation to the ontological questions *why is there something rather than nothing* and the aesthetico-epistemological question *how are things thus rather than otherwise* that he posed.[143] This does not mean prying Leibniz's thought out of its metaphysical hinges; rather it looks at some aspects of the concept of finite monads in the light of the non-integrability seen here in the second chapter, to explain how the logic of possibility rests on finitude as a condition that *could not be otherwise*. This is crucial for the understanding of finitude as a positive condition that generates presence. It also helps articulating in depth the radical impact this has on the notion of aesthetics as the outer face of representation, thereby reconceptualising it as the logic of sense of the present (making sense), rather than the mere level of phenomenological appearance.

For Leibniz the logic at the core of ontology is *possibility*, Being expresses infinite possibility. It is a determination of this possibility, a finite degree of this perfection that engenders the passage of possible metaphysical entities into historical and contingent existence. Leibniz repeatedly points out that the series of sufficient reason in historical contingency cannot provide a reason for their ultimate existence. This resides instead in

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[142] This is a point that returns often in Stengers' work and in her collaborations with Ilya Prigogine. Cf. Stengers, "The Leibnizian Constraint," in the *Invention of Modern Science*, 15-18; Cf. also Prigogine and Stengers, "Il Problema del Tempo" (The Problem of Time) and "Uomini e Dei" (Men and Gods) in *Tra il tempo e l'Eternità*, 21-33, 34-45; and Ilya Prigogine and Isabelle Stengers, "Postface: Dynamics from Leibniz to Lucretius," in Michel Serres, *Hermes: Literature, Science, Philosophy*, eds. and trans. Josué V. Harari and David F. Bell (Baltimore, MD: Johns Hopkins University Press, 1982), 135-158.

[143] Leibniz introduces the principle of sufficient reason in the "Principles of Nature and Grace Based on Reason," and in "The Monadology." Cf. Gottfried Wilhelm Leibniz, § 7-8, "Principles of Nature and Grace Based on Reason;" and § 31-48, "The Monadology," both in *Discourse on Metaphysics and Other Writings*, trans. Robert Latta and George R. Montgomery, ed. Peter Loptson, (Toronto: Broadview, 2012), 103-113 and 115-134 respectively. Cf. also Gottfried Wilhelm Leibniz, "On the reason why these things exist rather than other things," in *The Shorter Leibniz Texts*, trans. and ed. Lloyd Strickland (London: Continuum, 2006) 30-31.

what he calls an "extramundane" realm of ideal reasons, or metaphysical divine realm.[144] However, Leibniz further specifies this in such a way that the two questions, why something rather than nothing and how are things thus rather than otherwise, cannot easily be kept apart without undoing the organisation of the existing universe: "the same reason that brings it about that these things exist rather than other things, also brings it about that something exists rather than nothing," in spite of the fact that nothing is simpler that is more economical than something.[145] However, while these two questions are tightly intertwined, Leibniz makes an interesting remarks about the *why* question: "we must first acknowledge, from the fact that something exists rather than nothing, that there is in possible things i.e. in possibility or essence itself, a certain demand for existence."[146] This acknowledgement amounts to an acceptance that the extramundane cause provides the ground of necessity for possibility but it is not itself permeable to enquiry or explanation. Therefore when irreversibility severs contingent causality from this first cause, all emphasis for an explanation of the logic of such possibility shifts onto the forms of organisation addressed by the second epistemological question.

To be precise: Leibniz states that "possibility is the principle of essence," while existence is the result of a degree of perfection, as a finite determination of this essence "perfection" "is the principle of existence." It is finitude as a degree of determination of the actualised infinity of possibility that sanctions the passage to existence of metaphysical entities.[147] This is precisely what becomes reversed after complexity. As will be seen, possibility becomes the principle of existence because the passage to the ultimate, or essence, is no longer possible; therefore existence depends only on existing degrees of

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[144] Cf. Gottfried Wilhelm Leibniz, "On the ultimate origination of things," in *The Shorter Leibniz Texts*, ed. and trans. Lloyd Strickland (London, Continuum, 2006), 31-38.

[145] Cf. Gottfried Wilhelm Leibniz, "On the reason why things exist rather than other things," in *The Shorter Leibniz Texts*, 30; and Gottfried Wilhelm Leibniz, §7, "The Principle of Nature and of Grace, based on Reason," in *Discourse on Metaphysics and Other Writings*, 109.

[146] Cf. Leibniz, "On the ultimate origination of things," in *The Shorter Leibniz Texts*, 32.

[147] Cf. Ibid., 34.

existence, or finitude, while metaphysical necessity is rejected as yet another arbitrary idealisation.

What is at stake with the radical finitude encountered in non-integrability is that the question *why something rather than nothing*, which addresses a pure cause already for Leibniz, is unable to lead to the pure passage from nothing to something before attributes or determinations apply to the matter of the present, as if givenness could be detached from the specific contingent and historical determination of the given. On the contrary, radical finitude demands determination, or *roughness*, as the condition of this passage into existence. So that answering the question how are things thus rather than otherwise, that is answering the contingent question, provides the answer also to the question that aims at sufficient reason as the ontologically necessary, which explains why there is something rather than nothing. In other words, determination is both the matter and the logic of possibility; it is the necessary condition for there to be something. After complexity (non-integrability) the two questions inherited from Leibniz become one. The reason, the ultimate ground or transcendental limit, is not obliterated, rather the progress of complexity and irreducibility generates an irreversible chrono-logical distance (the irreversibility generated by non-integrability) that makes the initial input not simply insufficient for explaining the surface of the present, but rather *not relevant*.

As will be seen, in the light of non-integrability, the logic of compossibility proposed by Leibniz permits an entire reversal of the metaphysical hierarchy where possibility creates necessity. The possibility of sense lies with the finite determination of this contingent and present universe, with its roughness. Or better, only roughness, the determined pattern of finitude, can allow sense. Anticipating the conclusions, it can be claimed that complexity theory answers the question how are things thus rather than otherwise with a solution that introduces a radically new form of materialism where pure ontological existence and aesthetic-epistemological organisation are no longer separable conceptual moments.

Compossibility - With the notion of adjacent possibility Kauffman has underlined what Prigogine had shown for non-integrability: contingent existence is irreducible and the

very idealisation of such integration is not simply impossible but meaningless, because possibilities are not circulating on a metaphysical plane (or immanence plane) from which they would become actualised. Rather the actualisation is a local process of production of further actual organisations from what is already actual. Even at ontological level, the possibility of existence cannot be considered pure, as a pure Being or pure virtual (the pure event advocated by Deleuze), finitude acts as the matter and the fuel for the new to emerge.

A similar emphasis on the radical determination of finitude as the conditions of the movement from actual to actual can be found in the interpretation that John Ó Maoilearca proposes of Bergson's "actualism."[148] Aiming at rebalancing the excesses of the philosophy of the virtual introduced by Deleuze, Ó Maoilearca shows how for Bergson processes are not the actualisation of pure and empty forms of existence. Rather, virtual and actual hold reversed ontological roles than they do for Deleuze. Building on Leibniz's image of the perspective that each individual monad has of the entire universe as mirrored in the divine gaze, Ó Maoilearca shows how Bergson interprets each of such perspectives as a process of "refraction" (the bending of light waves through a medium.) This "optical metaphor" represents a local distortion and condensation of the real, which projects a liminal or virtual point of view on an otherwise indefinite substance. However, as light does not exist in itself but it is only encountered refracted through a medium, refraction is necessarily always an actual process.

The binaries of ontology are thus turned around: the virtual does not provide the ontological ground for the actualization of the present, rather it is a "psychological artifact", a product of perception; a distortion that projects an endpoint only ideally. Therefore, refraction as a perspective, Ó Maoilearca explains, is not a differential from the pure event as instead actualisation is for Deleuze; rather, it is the unavoidable "as if," the "seeing as" that shapes the encounter with the world. It is an "act of containment", a limitation that

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[148] Cf. John Ó Maoilearca, "Forget the virtual: Bergson, actualism, and refraction of reality," *Continental Philosophy Review 37*, (2004): 469-493.

transforms an "indeterminate realm into a determinate one." In fact, this is a "theory of mediation," where the media are the very processes of individuation and becoming. From here, Ó Maoilearca goes as far as proposing "an Actualist genesis of the Bergsonian virtual." Indeed, it is the image of the real generated in refraction that is a process of virtualisation. What is more, this virtual emerges as the "well founded phenomena" of the contingent and the aesthetic.

Howard Caygill has elaborated further on the containment that perception produces in refracting the actual world, showing that the limitations of the virtual perspective constitute an aesthetic condensation of an otherwise material and perceptible actual totality of the real (hyperaesthetic). Thereby not only relinquishing Deleuze's interpretation, but - most importantly- showing that the difference between the ontological poles of virtual and actual is one of *degree* rather than one of *nature*.[149]

These analyses that Ó Maoilearca and Caygill propose go very far in clearing the metaphysical ballast that weights down the deleuzean virtual; perhaps they reach the furthest possible within the space of the ontological ultimate. However, as will be seen in Chapter 4, non-integrability and the finite roughness it produces do not act as a light shown on an otherwise indefinite substance (refraction). Instead, dimensionality names the circulation of segments of sense independent of any ontological background, where it is the very possibility of thinking an ontological zero that has lost all legitimacy and relevance. Indeed, the determination of finitude that Poincaré had individuated is not psychological. Roughness is not a phenomenological problem; rather, it is intrinsic and constitutive to the existence of the world of sense/universe. As seen in Chapter 2, Stengers had already made clear how measurement does not act as a mediation -albeit unavoidable- between observer and matter (the "seeing as"), but is instead constitutive of physics. Shifting the emphasis on Leibniz's logic of compossibility opens an alternative path.

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[149] Cf. Howard Caygill, "Hyperaesthesia and the Virtual," in *Bergson and the Art of Immanence; Painting, Photography, Film*, eds. John Ó Maoilearca and Charlotte de Mille (Edinburgh: Edinburgh University Press, 2015), 247-259.

In Leibniz's system, God creates the monads, which are "the veritable atoms of nature."[150] From there on the evolution of the universe is submitted to constraints that determine its organisation. God only acts as a judge of the best combinations. In this sense the logic of compossibility that leads to the event of existence for Leibniz is not dissimilar from the logic of self-organisation that rules the finite present for Prigogine and Kauffman. Determination acts as the logic of emergence; the power of infinite possibility, God, is "undetermined," but only the combination of constraints such as goodness and reason "determine him to produce the best."[151] The strife for existence, the fact that the world exists and evolves accepted earlier as unquestionable, immediately becomes constrained by the laws of its very existence. Finitude is a genetic feedback loop that constructs reality rather than limiting it.

The crucial point for Leibniz is that:

"not all the possibles are compatible together in one and the same world sequence, for that very reason all the possible cannot be produced" […] "as soon as God has decreed to create something there is a struggle between all the possibles, all of them laying claim to existence, and that those which, being united, produce most reality, most perfection, most significance carry the day. It is true that this struggle can only be ideal, that is to say it can only be a conflict of reasons in the most perfect understanding."[152]

The selection of the best series possible is ruled by a principle of *simplicity*, or economy, that chooses the maximum results than can be produced from the simplest axioms or boundary conditions. This production must respect the commensurability of the economy of sufficient reason. However, even Leibniz had to admit that this economy of simplicity cannot be always upheld: if the description of the present is as large as the present and cannot be compressed, the entire a priori logic that rules compossibility from

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[150] Cf. Leibniz, "The Monadology," §3, *Discourse on Metaphysics and Other Writings*, 115.

[151] Cf. Gottfried Wilhelm Leibniz, §130, *Theodicy: An Essay on the Goodness of God, The Freedom of Man, and the Origin of Evil*, ed. Austin Farrer, trans. E.M. Huggard (Charleston, SC: Bibliobazaar, 2007), 204-205.

[152] Cf. Leibniz, §201, *Theodicy*, 255-256.

outside (metaphysics) is no longer tenable and the a priori and consistent space of possibility constructed on commensurability breaks down.[153] Nevertheless, if non-integrability bars the passage to the pure infinite possibility of the divine mind, of which the finite created monad is a differential, the coherence based on compossibility does not collapse, but permits thinking possibility in open terms. In fact, once the passage to the ultimate of the infinite wisdom of God becomes impossible, the work of judgment through which God constructs coherence is transferred to the local environmental implementations of the organisation in question. Compossibility becomes a test of compatibility amongst the variations of contingency, once free from actualised infinity it provides a logic to support the coherence of adjacent possibility, as Kauffman had presented it. Indeed, compossibility is a logic oriented forward, open to the consequences of the implementation of present possibilities, it responds to relevance rather than reduction. If non-integrability interferes with the transition to the limit, where the totality of the possible is preserved, compossibility easily exceeds the commensurability of the economy of sufficient reason. The possibles "strive for existence in proportion to their reality" "so that "a world arises through which the maximum production of possibles takes place."[154] Crucially, their combination and their passage into existence is not based on the deterministic conservation of causality, but rather it is grounded in the consequences they can have, how causally effective they can be, and how much more reality they can generate. This constitutes an anchoring forward where relevance replaces essence as the ontological principle.

Before going ahead, it is important to grasp fully the ontological implications of the intersection of compossibility with complexity. In the light of non-integrability it has become evident that there is nothing pure in the event of emergence. The pure corresponds to the

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[153] Cf. Leibniz, §5 and §6, "Discourse on Metaphysics," in *Discourse on Metaphysics and Other Writings*, 62-64. This is also the concept of the halting point introduced by Gregory Chaitin in his interpretation of incompleteness via algorithmic information theory, or computability. Cf. Chaitin, "Digital Information: DNA/Software/Leibniz," in *MetaMath!*, 47-74. On Leibniz's simplicity and infinite complexity Cf. also Chaitin, "Leibniz Complexity and Incompleteness," http://www.quizover.com/oer/course/leibniz-complexity-and-incompleteness-by-gregory-chaitin-videolectures, accessed June 6, 2016.

[154] Cf. Leibniz, "On the Ultimate Origination of things," *The Shorter Leibniz Texts*, 33-34.

linear idealisation of ontology, which always imagines it possible to think existence prior to its attributes. Yet, Leibniz's system presents a strict totality: in the universe all individual monads are mirrored in the mind of God who guarantees their unity, continuity, and the chain of causality.[155] This organises the totality in which monads reflect themselves and find place and sense. Indeed, the principle of sufficient reason is one of the main pillars of Leibniz's thought and compossibility is the logic that keeps together the a priori necessity of reasons with the deterministic causality of matter in order to satisfy the requirements of the pre-established harmony of the universe. Harmony exists between the perceptions in the individual monad and the external motions of the bodies (the relation of cause and effect happens mirrored in the totality of God's mind),[156] and as the compatibility of Reason and Grace, which however is less strictly deterministic and functions as an open prescription that simply requires that there must be harmonic equilibrium.

This leads to the economy of compossibility where harmony balances the "greatest variety along with the greatest order;"[157] the most results produced in the simplest ways. Leibniz states that without this economy of simplicity "it would not be possible to give a reason why things have turned out so rather than otherwise."[158] This is quite important because with harmony Leibniz is not presenting a design to be fulfilled but rules to be applied. The contingent universe is potentially infinite and yet for Leibniz this infinity does not constitute a totality. Indeed the logic of compossibility is closer to algorithmic iterations than to a teleological totality. Therefore, Leibniz seeks a rational explanation that can account how the present has arrived to be what it is without allowing randomness or contradiction, which would instead make it vulnerable, at risk of precipitating into disintegration at any moment. However, once non-integrability severs the links between individual finite monads and the metaphysical unity of the universe, the coherence of this

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[155] Cf. Leibniz, §56 and §57, "The Monadology" and §8 and §9, "Discourse on Metaphysics," in *Discourse on Metaphysics and Other Writings*, 115-134 and 57-102.

[156] Cf. Leibniz, §3, "The Principles of Nature and Grace, based on Reason," in *Discourse on Metaphysics and Other Writings*, 105-106.

[157] Cf. Ibid., §10, pg 109.

[158] Cf. Ibid., §10, pg 110.

universe, its possibility of making sense, can be entrusted only to the a contingent form of compossibility, which alone can explain the present. In other words, once the divine guarantee of order is barred by the impossibility of idealisation, cut from the totality reflected in the mind of god, the *pre-established* harmony that Leibniz advocates becomes only an *established harmony*. That is, the synthesis of compossibility results from a process that generates coherence as equilibrium; it is an ecological balance emerging retroactively.

This is less dissonant with Leibniz's logic than it would seem at first. However pre-established, for Leibniz the only prescription is that things must be in harmony, while the configurations of this harmony are contingent. Harmony expresses the necessity of equilibrium. This equilibrium is transcendental, not at the limit but open in its forms. The rational law and the moral good are its components rather than its target. The universal harmony expresses the consistency of the history of the universe, it is not divinely orchestrated.[159] Missing this distinction misses the point entirely.[160]

Moreover, compossibility is the expression of the principle of simplicity.[161] This constitutes a peculiar kind of ontological economy; one based on parallel comparisons rather than a linear relation between identity and its contingent objects. In fact, it is an economy oriented towards the future; a genetic rather than a representational logic. The unity of the universe in the mirroring mind of God, through which each monad has an image of the entire universe, constitutes a logic of equilibrium or ecology rather than a form of representation of a priori principles. In this light, what is possible in the contingent universe of existence is always a result, rather than being set a priori.

Leibniz identifies simplicity with the *principle of fitness*, which rules the maximization of effects of finite simple causes in the combination of monads in the pre-established

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[159] Cf. Peter Lopston, "Introduction," in Leibniz, *Discourse on Metaphysics and Other Writings*, 44.

[160] In this regard, the irony with which Voltaire treats Leibniz is misplaced. Voltaire assimilates the "best" with a totality of morality centred on the human individual which foreshadows Kantian ethics. *Candide* evaluates right and wrong as if they were ready at hand as absolute positions that rest on the individual subject as the causa finalis, a final reason in function of which moral judgment would act. Cf. Voltaire, *Candide ou L'Optimisme*, edit. Alain Sandrier (Paris: Gallimard, 2003).

[161] Leibniz, §5-6, "Discourse on Metaphysics" and §58, "The Monadology," in *Discourse on Metaphysics and Other Writings*, 62-64 and 127.

harmony.[162] This is the pivot where it is possible to turn to Kauffman's interpretation of evolutionary selection of random variations and self-organisation. Harmony does not prescribe a specific organisation for compossible series, nor does it state what this maximum variation should be, rather it only imposes that the generation of more complexity should be the maximum possible. This is reflected in the process of adjacent possibility leading to ontological emergence presented by Kauffman. Maximum organisation is equal to maximum options of repetition and reproduction: maximum possibilities of linking the new emerged series/organisation with the existing environment so that the mutations induced by the adjacent possible can take hold in the present and repeat; that is become part of the existing network. In other words, maximum compatibility and the best compossible solution are judged retroactively. There is no absolute measure for the success of such organisations; only a retroactive reciprocal comparison established from the expansion of the existing network produces a synthesis.

The *order* of existing things, the harmony of wisdom (logic) and grace (morals), is *equilibrium*. For Leibniz, God does not create the universe; God only creates the monads, which Leibniz presents as the "veritable atoms of nature." Then God is bound by the laws of nature (physics/dynamics) and grace/morals to combine such monads/axioms in the most productive way possible (Leibniz could be said to downgrade God from the figure of an almighty creator, to the role of a processor of algorithms). This keeps the equilibrium of harmony *open*. As it was for Prigogine, equilibrium is the expression of a metastability, or incompleteness; where order emerges through dissipation rather than fulfilling a priori structures. New events will change its configuration. The only requirement being that the universe remains coherent. It is incompleteness that both demands the best possible and frees it from the absolute reference of morals, which would disprove the choice of this current universe as the better solution over other versions/combinations. What is possible dwells in this metastability.

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[162] Cf. Leibniz, §11, "The Principles of Nature and Grace, based on Reason," in *Discourse on Metaphysics and Other Writings*, 110.

Possibility and Necessity - In a passage of The Monadology, Leibniz articulates how possibility finds its ground in metaphysics. If a necessary being (God) is possible, then it must necessarily exist. "Existence –Leibniz writes- is a simple consequence of its being possible" since a necessary being is "incapable of limitations and must contain as much of reality as possible." Moreover, "perfection is nothing but an amount of positive reality," which in a necessary being is infinite. While, the imperfections of created monads "arise from their own nature" [their finitude], since they are "incapable of existing without limits"; it is a privative differential. Possibility and essence coincide and belong to the "region of eternal truths;" that is, God. "Without him there would be nothing real in the possibilities of things." Lastly, God is a "necessary being" for whom "essence involves existence;" for God "it is sufficient to be possible in order to be actual."[163]

In other words, if something necessary is possible, if it is possible that a necessary being exists, then -according to Leibniz- it will necessarily exist. Existence, therefore, derives its reason and ground from the a priori necessity in its purest form. Necessity gives power to possibility. This constitutes Leibniz's ontological proof in simple and powerful manner. Contingent and finite existence is instead presented as a differential from totality and needs to retain a relation with this in order to function. It needs to imagine a perfect being for which attributes and qualities are all in infinite quantity, or indeed apply as absolute qualities. Leibniz clarifies that existing organisations are "combinations of unity and zero; or rather of the positive with the privative," where this privative acts as the limit of the properties of a given determination.[164] The example that Leibniz brings is that of a point at the end of line, which is "nothing more than the negation of the progress beyond which it ends." However, these limits or privatives are determinations that belong the contingent existence, while the positive express a degree of perfection, which reflects the metaphysical

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[163] Cf. Leibniz, § 40-44, "The Monadology," in *Discourse on Metaphysics and Other Writings*, 123-124.
[164] Cf. Leibniz, "Letter to André Morel" (4/14 May, 1698), in *The Shorter Leibniz Texts*, 39.

absolute (God).[165] This is the "extramundane" ground or reason that Leibniz adopts for the series of contingent causation in the created universe.[166]

God's possibility of existence is calculated as a mathematical absolute, an "it is" or a "there exists" without further qualifications or attributes, outside space and time. In other words, it states that if necessity is thought of ontologically, then there must exist an ontologically necessary being. It is a formulation of logical self-sufficiency that provides the ontological proof a priori and takes place before considering the absence or the presence of a contingent limit. It is, indeed, a proof of immanence of totality. Instead, finite imperfect monads need to be created, they cannot turn their finite possibilities into a reason for being ontologically possible, they are -in Leibniz's view- controlling their possibilities only contingently or epistemologically as local and contingent possibilities.

When non-integrability interferes with this ontological ultimate; when it shows that this original "extramundane" cause is only an arbitrary idealisation, the ground of possibility of the finite monads would either vanish, or be provided through the compossibility of the patterns designed by the privative limits. Indeed, as was seen in Chapter 2, non-integrability reverses the totalising image of the universe. If one stayed with Leibniz, as with any other metaphysical idealisation, the result would be paradoxical: deprived of a reason for being, finite imperfect monads would instantly disappear; in fact, the entire universe would vanish at once. However, since this does not seem to be the case, another reason must be at play in supporting presence, and providing a logic for the existence of monads and their serial organisations; a logic, that is, for our contingent and historical presence in the present. This logic is the fact that finitude is positive. It is all that there is, and the coherence that keeps the universe of sense together is the retroactivity of the synthesis of finite possibilities (adjacent possible) that become implemented in what is already existent. That is, the logic becomes one of *diffraction* and *relevance* constructed on a compossibility that is measured amongst other parallel possibilities rather than against absolute divine judgment.

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[165] Cf. Ibid., 39.

[166] Cf. Leibniz, "On The ultimate Origination of Things," in *The Shorter Leibniz Texts*, 31-38.

For Leibniz contingent existence is a degree of perfection, a finite amount of quality actualised that requires complete determination in order to cohere, while total perfection is the ideal metaphysical region of actualised infinity of the divine mind.[167] This determination amounts to sufficient reason: nothing would come into existence if the instruction/information regarding some of its properties would remain undefined. In fact, acting without a reason would amount to act against reason.[168] Thus, finitude is already the ground of contingent existence where imperfection amounts to a *pattern of determinations* that may or may not match that of another finite substance. This is the same problem about the impossibility of absolute measurement that was introduced by Poincaré - as was seen in Chapter 2. "God in the beginning ordered one substance in accord with another in proportion to the perfection or imperfection that there are in each."[169] This is the elementary mechanism of compossibility. It is the same as the pattern that would result from a given degree of precision in a sequence of decimal numbers, which would have to be determined at each decimal step, so that each decimal figure would be in one of ten possible options, till the last one after which instead an absolute choice of stopping the sequence would take place. Each sequence is then determined both along its decimals sequence and in the number of such decimals (or length) producing a pattern not unlike the jagged edge of a key. Each series, that is, is a pattern or a rhythm and it can combine only with compatible pattern-rhythms; otherwise it continues its iterations blindly. Given the infinite divisibility of matter or numbers that Leibniz postulates, there is here an infinite amount of possibilities for each decimal figure, which means that between number and number there can be in infinite amount of infinitesimal points of determination, and each again can be divided to infinity. In this light, the finitude of each series constitutes a positive pattern; that is, it does not need or refer to the options that are not actualised. As was seen above, imperfection is privative; it marks the point beyond which the properties of the being cease to apply, it is not external

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[167] Cf. Leibniz, §130 and §201, *Theodicy*, 204-205 and 255-256.
[168] Cf. Ibid., §196, 252-253.
[169] Cf. Ibid., §66, 162-163.

negation or a lack. It can be considered a differential from totality only if the idealised unity is retained in the form of a transcendental or virtual identity. Likewise, there is no ultimate for each of these options. In a non-integrable system, both the zero and the one (number 9 in a decimal scale) are degrees equal to any other along the range of possibilities. The zero is not the ultimate limit; rather it is only the point where the information simply expresses the instruction not to act, a vector that carries no information and therefore passes to the next decimal.

Stuart Kauffman's description of the local emergence of possibility is not dissimilar from this pattern cut into the labyrinth of the continuum that Leibniz sought to explain. The possibilities of development of a process are constrained by the contingent history of the process. Work is a release of energy into "few degrees of freedom" dictated by the configuration or organisation of the present.[170] However, for Kauffman constraints are not a semantic vehicle for information, an interpretation that would still constitute representation, rather "information is nothing but the constraints themselves."[171] Interestingly, Kauffman makes reference to the same problems of information entropy that led Prigogine to formulate the concept of the entropy barrier, which forbids reversibility acting as a cosmological constant. In fact, the entropy of information encountered by Shannon and the problem of the shortest program able to produce the complexity of the present described by Chaitin directly refer to the economy of *simplicity* that supports compossibility for Leibniz.[172] As will be seen in the next chapter, this identification of information and constraints will play a fundamental role in the reconceptualisation of aesthetics as a logic that makes sense; it also acts as the structure for Stengers notion of practice where constraints express a genetic logic that points directly to the creative practice of art.

Finitude, Constraints and Leibniz - The argument of finitude as it is posed in the thesis, as positive finitude, moves between the *idealism* of metaphysical essence and the

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[170] Cf. Kauffman, "The Cycle of Work," in *Reinventing the Sacred*, 88-100.
[171] Cf. Kauffman, *Reinventing the Sacred*, 97.
[172] Cf. Ibid., 95. For the argument of simplicity Cf. Leibniz, §5 and §6, "Discourse on Metaphysics," in *Discourse on Metaphysics and Other Writings*, 62-64.

materialism of contingent existence that can be seen as splitting Leibniz's system.[173] The economy of compossibility organises the passage from the first to the second (how are things thus rather than otherwise), but it still requires the extramundane divine input to justify its work (why is there something rather than nothing). As was seen, this would be impossible in a non-integrable system. Without an alternative solution, this would lead once again to total randomness or to nothing. This alternative solution comes from Kauffman's notion of finitude of information, which acts by constraining the process of evolution and the increase of information or complexity. Non-integrability breaks totality open and permits interpreting monads as finite strings of information whose organisation is a progressive increase in complexity, till reaching the level of matter, or physical presence as organised matter; both endowed with sense (soul) and embedded in sense (harmony). The distinction made by Leibniz between inert matter infinitely divisible and metaphysical monads presented as the real atoms of nature would bar this progress.

The interpretation of finite information proposed by Kauffman bridges this gap for a positive grasping of finitude, which does not need information to be attached to matter as a predicate - as instead Deleuze would still want in his interpretation of Leibniz. For Kauffman, finite information, as the monad does, constrains *work*; it limits it and gives it a pattern, whether this is the work in a cell or any other process, or compound of monads. That is, finitude gives shape and makes place. As such, this bridges the material-immaterial separation that sees bodies (inert matter) and substances (information monads) kept apart. The notion of constraints not only shows that finite strings of information are positive, but most importantly it shows that finitude provides the reason for *presence*. That is, the material and chrono-logically organised presence of the present; or *aesthetics*; an aesthetic presence, however, which can no longer be reduced to an ontological substance.

Leibniz reiterates that for there to be sense –organisation, order- matter is required. A disembodied universe, composed only of spirits, or pure possibilities, would be a smooth

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infinity where nothing sticks and harmony could never be installed and sense would never emerge.[174] Missing one or another determination would prevent the existence of the being that is defined by that determination. Then the problem remains: how these beings can cohere and exist if there is no passage to the ideal ultimate of perfections? Leibniz had in fact already provided the solution -albeit unwittingly. The economy of simplicity is the reason that makes something that is randomly emerging stick, repeat, reproduce; *make sense* that is. The demands of the economy of simplicity really speak to the ontological emergence of evolution articulated by Kauffman, and acts as the *anchoring forward*, or retroactivity of the synthesis of the present. This is a ground that is constructed by the very implementation of the random emergence of new possibilities. It is indeed the possibility of continuation that makes present possibilities possible, as necessarily possible; that is, gives this possibility the logic and the rigour, strength to cohere and resist, to endure, to exist. As there is no a priori infinity of possibility striving to become actual all at once, but a local and heterogeneous generation of possibilities whose power of existence resides in the implementation via the adjacent possible that these possibilities generate with their very emergence. Compossibility organised on the ground of simplicity (the economy of the smallest expenditure and the maximum production), *draws the necessary out of the possible*. It is the implementation of possibility that generates necessity.

This construction of possibility is exquisitely relational. Heidegger always waits around the corner, both smiling about having thought of it in the most abstract terms and also grinning at the risk that this relation is vulnerable to the capture of the onto-theo-logical paradigm which always waits behind the same corner.

3.5 Compossibility between Leibniz and Deleuze

While non-integrability bars the idealisation or reduction of contingent causality chains to a first cause, as in Leibniz's extramundane God, it is also important to see how

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[174] Cf. Leibniz, §120, *Theodicy*, 194-196.

the finitude that ensues non-integrability no longer allows the ontological separation of attributes from existence as if these were circulating independently in pure form, or, as Deleuze puts it, in a pure pre-individual form.[175] This is of particular importance because it prepares the terrain for understanding how positive finitude is not only abandoning the metaphysical structure of linear ontology, admitting that elements cannot exist a priori independently of their relation, but it also challenges the Heideggerian interpretation of relational identity as a *unique* and essential relation; a uniqueness which returns in Deleuzean ontology. Indeed, Heidegger describes the event of appropriation that binds beings and Being in their relationship generating the ground of their coherence, as an event that takes place "uniquely," outside the discrete distribution of contingent quantity and residing in the realm of pure ontological existence. This is directly reflected in Deleuze's image of an "eventum tantum," which would embed all historical and heterogeneous events.[176] Both these approaches to the logic of sense, cannot avoid repeating the traditional disembodiment of the present that ontology has always operated. On the contrary, the radical finitude put forward in the thesis permits explaining how the heterogeneity of the local and contingent possibilities cannot be reduced or idealised to any form of existence deprived of determinations, while it nevertheless retains coherence. As will be seen in Chapter 4 this has a direct impact on the separation of object and concept, or the dualism of matter and immaterial, which ontology has never been able to dispel fully.

For Deleuze, Leibniz's compossibility expresses a *converging* logic.[177] This becomes the key for the interpretation that he puts forth of Leibniz's image of totality, where each finite monad expresses the entire universe via a mirroring reflection in God.[178] He writes:

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[175] Cf. Deleuze, "Twenty-Fourth Series of the Communication of Events," in *The Logic of Sense*, 194-202.

[176] Cf. Heidegger, "The Principle of Identity," in *Identity and Difference*, 23-41; and Deleuze, "Twenty-First Series of The Event," in *The Logic of Sense*, 169-175.

[177] Cf. Deleuze, "Sixteenth Series of the Static Ontological Genesis," in *The Logic of Sense*, 126-135.

[178] For Leibniz, the ontological metaphor of the mirror is key to guarantee the unity of the universe and the continuity of causality as well as to support the economy of compossibility. Cf. Leibniz, §8 and §9, "Discourse on Metaphysics", and §57 and §58, "The Monadology," in *Discourse on Metaphysics and Other Writings*, 65-67 and 127 respectively.

"*this convergence defines compossibility as the rule of a world synthesis.*"[179] Compossibility thus is defined as operating between "differential relations and contiguous singularities" and progressively constructing their convergence into a unity, which amounts to a process of continuous creation not dissimilar to that seen in Kauffman's theory.[180] Where the continuity of compossibility runs into obstacles that prevent concluding the convergence, the series diverge and a new incompossible series/universes begin. Deleuze recognises that this incompossibility is not reducible to linear one to one contradiction; rather it expresses the non-convergence of complex wholes which diverge in proportion to the information entropy they have accumulated.[181] However, the ecological aspect, or equilibrium of the unity generated by the logic of compossibility, which is shared by Leibniz and Kauffman, does not have a place in Deleuze's interpretation. In fact, his version of compossibility retains a metaphysical approach that still keeps substance and predicates apart, albeit in transcendental form.

Possibilities, that is individual bare monads, for Deleuze circulate as a "*continuum* of singularities" that are pre-individual and entirely distinct from contingent and historical existence. In his view, "if it is true that the expressed world exists only in individuals and that it exists there only as a predicate, it [also] subsists in an entirely different manner, as an event or a verb."[182] Contrary to this, what must be emphasised in the light of non-integrability and adjacent possibility is that once the idealisation-reduction towards the pre-individual or pure event/verb is barred, the predicates are all one has and all one can engage with. In fact, the predicates or finite determinations are all the predicates themselves have and can engage with in the construction of networks of adjacent possibility.

Heidegger warning against the onto-theo-logical risk echoes here, showing how much ontology embodies the grammar and syntax of the verb to *be*, so that it is possible to

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[179] Cf. Deleuze, *The Logic of Sense*, 127.
[180] Cf. Ibid., 127.
[181] Cf. Ibid., 127-128.
[182] Cf. Ibid., 128.

predicate something of 'x' and still think of the existence of 'x' as separate from the predicate, and of the contingent predicate as the expression of a pure quality.

For Leibniz the finitude of the created monads is a differential from an infinite quality, or perfection, which the finite monad cannot attain. In fact, the created monad can only exist thanks to the determination of its finitude; it does not exist before being determined by predicates. Perfection is "nothing but an amount of positive reality", imperfection, and sin, instead arise from the "incapability of existing without limits."[183] This is paramount for Leibniz: pure existence is as metaphysical as perfection and exists only in the divine mind. On the contrary, the contingent existence can exist on the base of finite properties combined and measured for their causal consequences.

Where Leibniz expresses a distance and an impossibility, which foreshadows the genetic limits of finitude introduced by cosmological constants three centuries later, Deleuze instead reinstalls a transcendental continuity between the pure and the contingent. The predicate as a determination expresses a quality that exists virtually or metaphysically as a pre-individual singularity: "to green [Deleuze writes] indicates a singularity-event in the vicinity of which the tree is constituted," equally, "to sin" indicates a singularity-event in the vicinity of which Adam exists and sins.[184] While the identity of this virtual is constructed via a speculative process, there still remains a space laid out by such pure qualities which forecloses the openness of irreducible finitude where possibility is genetic rather than representational. In fact, the singularity is the present: this tree with this precise shade of green. Once again ontology performs arbitrary idealisations: "to green," to sin, or indeed *to be* can function as a useful abstraction, but have no pure ontological existence.[185]

In fact, what is at stake here are different interpretation of convergence and divergence, which radically alter the concept of possibility. Deleuze emphasises that

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[183] Cf. Leibniz, §41 and §42, "The Monadology," in *Discourse on Metaphysics and Other Writings*, 124.

[184] Cf. Deleuze, *The Logic of Sense*, 128.

[185] Supra: As it will be seen in the next chapter, this idealisation can be retained as an object of thought rather than its horizon and coordinate.

compossibility and incompossibility do not reflect the identical and the contradictory.[186] In fact, it should be added, their logic is both plural and geared towards a continuous expansion in all directions, the "and… and… and..." rather than the "either or" of binary branching. The difference between Deleuze's interpretation of compossibility and the light complexity shines on it resides with the ontological hierarchy that Deleuze retains. For him, the compossible series express an event-singularity circulating at pre-individual level; while after complexity, that is on the light of non-integrability, this is reversed. The event-singularity (no matter if transcendent as for Leibniz or transcendental as Deleuze's virtual) is an arbitrary and illegitimate idealization and the contingent determinations of the compossible series become primary. The event does not express a possibility, but rather it is the expression of a possibility, or combination of possibilities.

Deleuze advocates a non-negative image of divergence (or incompossibility), which he thought Leibniz could not avoid because he was "hindered by theological exigencies" that for Deleuze kept Leibniz's thought ultimately anchored in metaphysics and an existence discrete and yet transcendent; while the transcendental idealisation he proposes would keep incompossible series in communication via their undetermined limit.[187] In reality, the chrono-logical irreversibility of complexity excludes the theological exigencies that would have led Leibniz to retain a metaphysical structure for ontology as much as it bars the transcendental and pre-individual horizon of deleuzean ontology. Non-integrability bars the passage that would allow the communication of events on a plane of immanence. Therefore contingent possibility is not the expression of an undetermined pure singularity, but it is itself a singularity, whose finitude does not permit idealisation.

It is important to point out that how delicate is the notion of a space of possibility that Leibniz lays out for compossibility to act. In fact even before non-integrability intervenes barring metaphysical abstractions, the notion of pre-established harmony presents a very peculiar form of order. In fact in Leibniz universe, the created monads, matter, the principles

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[186] Cf. Deleuze, *The Logic of Sense*, 196.
[187] Cf. Ibid., 197.

of sufficient reason and of divine grace, and God's judgment in organising them all come together as independent elements in need of a balance. God does not create the universe, but instead performs an evaluation of the consistency of the possibilities that the initial conditions permit, in order "to obtain as great a variety as possible but with the greatest possible order" to maximise the products of the differential of finitude.[188] That is, the pre-established harmony does not dictate *how* things must cohere, but only *that they must cohere*; it acts as an ecological transcendental requirement rather than a Euclidean a priori space.

Deleuze is concerned with undoing the space installed by a priory identity. He hopes that "predicates may remain undetermined without acquiring a character of generality" that imposes ontological hierarchy.[189] Yet, this indeterminacy leads to ontologise the local and heterogeneous zeros of contingent determinations, while avoiding generalisation does not dispel idealisation. It is this disassociation of the existence of the finite monads from their determinations presented as predicates (rather than a local pattern of finitude) that induces Deleuze to overlook the chrono-logical irreversibility necessary for compossibility as a logic of existence, both in Leibniz and in complexity, and to formulate the immediate ontological passage of actualisation and counter-actualisation; where the present is constantly tangent to the transcendental limit of ontology.

The distinction that must be clear here is that Deleuze aims to "make divergence an object of difference as such".[190] This is the process of actualisation as a differentiation from the virtual or transcendental continuity, where possibility would still be engendered by a principle that exceeds its contingent presence. Yet, in the light of Kauffman's interpretation of incompleteness, each synthesis of coherence is both a moment of divergence from the previous existing-historical and contingent coherence and a moment of convergence onto a new form of organisation. This emergence of possibility as ecological equilibrium, or

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[188] Cf. Leibniz, §58, "The Monadology," in *Discourse on Metaphysics and Other Writings*, 127.
[189] Cf. Deleuze, *The Logic of Sense*, 129.
[190] Cf. Ibid., 130.

compossibility, becomes possible at the moment of coherence without actualising pre-individual forms and, at the same time, it does not undo the forms upon which it grows re-merging in the smooth isotropy of the plane of immanence each time change occurs.

Reflecting the eventum tantum or unique event, Deleuze would like to retain an upstream continuity amongst incompossible universes:

"Incompossible worlds, despite their incompossibility, have something in common – something objectively in common- which represents the ambiguous sign of the genetic element in relation to which several worlds appear as instances of solution for one and the same problem (every throw the result of a single cast)"[191]

This is precisely the ontological preconception that forecloses a truly open possibility. The present as a singularity does not pose a problem seeking a solution. A singular present is complete, in the sense that it does not exist in the light of a priori or virtual identity and therefore does not express a lack; Gödel's incompleteness is not a differential from a totality, rather it is the impossibility of totalising the present. It is in this sense that finitude must be grasped as both positive and genetic. A singular present does not seek a generality. Unlike a common denominator, the genetic element operates in the present; in fact, it is the present. The logic of adjacent possibility shows how the present works as the engine that draws possibility out of actual organisations, rather than expressing an a priori or virtual necessity. The expansion of such finite present into the adjacent possible expands its space as well as its functionalities. These are operations of *expansion of the universe*, not *acts of expansion in the universe*.

Once irreversibility is accepted, the degree of reality of other incompossible universes parallel to the present one becomes irrelevant. Irreversibility bars any retracing, any backward move towards the point of bifurcation, as much as any direct influence of the original cause in the present. The amount of energy and information necessary to negotiate this chrono-logical distance is an infinite expenditure that generates an entropy barrier -as

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[191] Cf. Ibid., 130-131.

Prigogine had shown. Contrary to this, Deleuze's world is *flat*; tangent in all its points and moments to the ontological limit. Counter-actualisation keeps the present one step away from the metaphysical plane of pure ontological possibility, or Being. The completely open causality of difference (the dice throw) pushes Deleuze to overemphasise the absence of identity or design and to discard the historical aspect of evolution and ignore the complexity of sense in the historical present. This still captures possibility within an ontological frame.

In other words, by posing a virtual or "nomadic" identity that would move freely on the plane of immanence ready to become actual in a form that satisfies the distribution of this or that series, Deleuze's univocity jumps over the distinction that Leibniz had drawn between the ideal region of metaphysics where all possibilities are evaluated and the actual and historical existence, grounded in the causal effectiveness of the organisation of the present.[192] Incompossible worlds are not "variations on the same story."[193] Something had remained overlooked. For Leibniz, the compossibility of reason and grace never considers a single entity individually and independently from the combinations it is part of; the judgment is expressed instead upon plural and complex organisations whose emerging wholeness is that of a network rather than a solid identity. Aleatory points are open to bifurcations, as Deleuze sees it, but this does not mean that non-actualised possible branches are preserved. Moving freely, as Deleuze would like, in and out of the actual configurations of separate universes, would break universal constants of entropy and the speed of light. Indeed, for Leibniz, Adam's vagueness is not that of ontological quality (Deleuze's nomadic identity of the singularity-event). Rather, Adam is vague in the present, here and now, with regard to his future evolution.[194] This vagueness is not a virtual event/identity circulating disembodied across present configurations, but corresponds to Ljapunov's windows of

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[192] This distinction between a material-historical existence and an ideal existence is fundamental for Leibniz and recurs in several texts. It is presented with remarkable clarity in "On the Ultimate Origination of All Things" which is referred to here. Cf. Leibniz, "On the Ultimate Origination of All Things," *The Shorter Leibniz Texts*, 31-38.

[193] Deleuze, *The Logic of Sense*, 131.

[194] This argument about the absolute determinism in the divine mind and the finite degree of precision of the individuated human mind is the topic of the *Theodicy*, in particular the first section "Preliminary Dissertation on the Conformity of Faith and Reason;" Cf. Leibniz, *Theodicy*, 75-125.

limited precision and limited forecasting seen in Chapter 2. In fact, it is precisely having a finite body that makes Adam vague; that is, finitude is the reason for the impossibility of absolute calculations. At the same time, it is precisely the fact that Adam is organised *thus rather than otherwise that permits his existence*.

As non-integrability severs the link between the finite monad and the totality of the universe, which the monad reflects inside itself to find place and sense, another consequence arises. The "convergence" that Deleuze individuates in this mirroring logic of the monad towards a cohesive totality becomes impossible.[195] A notion of compossibility uprooted from totality by non-integrability, as it is proposed here, does not converge at all onto a unity or totality, which inevitably conceals identity, but diverges from the existent and converges locally onto a singularity each time. This confirms the logic of the adjacent possible. That is, adjacent possibility complements or completes non-integrability providing a logic that is non-unitary (heterogeneous), discontinuous and local and yet it has the rigour of necessity; it explains why things are thus rather than otherwise.

From this the chapter concludes that the combination of non-integrability, the non-reducibility of incompleteness, and the mechanism of the adjacent possible introduced by Kauffman constitute a logic of compossibility, which unlike Leibniz's model does not stem from a actualised infinity of the possible, albeit only at metaphysical level, and nevertheless it constructs an equilibrium or harmony whose synthesis is retroactive. This retroactivity is the ontological emergence, or logic of relevance, that Kauffman has introduced in evolutionary biology; it also points to the ecology that Stengers develops for ontology and politics and will become further articulated in Barad's notion of *diffraction*.[196]

What is more, this is also the logic of a mode of operation in art making that corresponds to contemporary practices, where the entire ecology of the present constitutes the aesthetics. Ecology here, borrowed from Stengers' "ecology of practices," names a logic

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[195] Cf. Deleuze, "Sixteenth Series of the Static Ontological Genesis," in *The Logic of Sense*, 126-135; and Deleuze, *Difference and Repetition*, 52-62.
[196] Cf. Karen Barad, "Diffractions: Differences, Contingencies, and Entanglements That Matter," in *Meeting the Universe Halfway*, 71-94.

where the traditional surface of aesthetics and the traditional essence/structure of ontology and epistemology can no longer be thought as separate.[197] To be precise: these two realms are not simply joined, they have instead become meaningless categories, unable to address and explain a presence whose reasons for existence and logic of functioning are generated in the assemblage of the present, as a network. As will be seen in Chapter 4, it can be anticipated that this constitutes a logic, whose *past* is genealogical rather than reductionist. That is, not a logic severed from its past, but one that cannot be reduced to its original conditions or axioms as if its history were transparent. On the contrary, the logic introduced here carries with itself all the variations and folds its history has generated; a logic where history is opaque and thick, to borrow Lyotard's expressions.[198]

What is meant by a logic of compossibility if the totality is unreachable and the harmony is not established a priori? For what concerns the image of a pre-established harmony, the situation is simply reversed: that combination of existing compounds which finds the most connections with the existing organisation of the present is the combination that -as Leibniz says- "will carry the day". That is, it will stick, remain, iterate and repeat becoming relevant and generating consequences, thus entering the causal chain.

Ultimately, the impact that non-integrability and incompleteness have on ontology goes beyond the subtraction of foundations and barring the path of reduction. What is shattered is a fundamental preconception of thought that in part was already highlighted by Deleuze in his critique of the image of thought. That is, incompleteness destroys the spatialised image of ontology, which Deleuze had described as the space in which recognition and resemblance take place under the sign of identity.[199] The present is not a threshold between the past and future, presented as probable or possible (to keep with Stengers distinction); the present is also not a state along a segment that is given prior to

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[197] Cf. Stengers, "The Course of Tolerance," in *Cosmopolitics*, Vol.2, 303-416.

[198] The notion of thickness is the metaphor Lyotard adopts to describe the event of organisation of the present in *Discourse, Figure*. Cf. Jean-François Lyotard, "The Bias of the Figural" and "Signification and Designation," in *Discourse, Figure*, trans. Antony Hudek and Mary Lyndon (Minneapolis: University of Minnesota Press, 2011), 3-19 and 23-156 respectively.

[199] Cf. Deleuze, "The Image of Thought," in *Difference and Repetition*, 164-213.

history. In fact, the present *is*, and it has been. It is *all that there is* but non-reducibility makes it finite. No ultimate ground and no transcendental limit can act as boundary conditions, defining how this present may evolve or how it may remain static. The present *is* and it is *open*. Openness allows for change to take place, but the rules of this change are dictated by the shape or pattern of the finitude of the present. It is on this openness that the demands of relevance and diffraction take hold constructing a new logic of sense, which will replace the static genesis of idealising ontology.

Compossibility, Simplicity and Complexity - Deleuze criticises Leibniz's notion of compossibility for being built as a converging logic that –to him- still reflects identity.[200] While it is correct that the principles of identity and non-contradiction play a major role in Leibniz's logic, the argument is more nuanced and leads to an interpretation that cannot be explained away through the dualism of convergence and divergence proposed by Deleuze, without overlooking other aspects of the process of coherence presented by Leibniz. Gregory Chaitin's analysis of the notion of *simplicity* that is at the core of the economy of compossibility (that is, of the economy that always produces the maximum possible results from the minimum possible expenditure, or simplest initial description or axioms) seems to point in the opposite direction.[201] The problem of simplicity as compressibility of information is the fundamental topic for Chaitin's interpretation of incompleteness regarding description in physics. Leibniz's compossibility, multiplying the results on the base of initial finite axioms reaches a point of non-predictability that diverges to infinity/infinitesimally so that the description or definition of the system-universe cannot be compressed (that is it does not converge) onto the initial axioms (simplicity), rather the entire history/description of the system is required for the definition.[202] Chaitin claims that this shows an irreducible infinite

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[200] Cf. Deleuze, "Twenty-fourth Series of the Communication of Events," in *The Logic of Sense*, 194-202.

[201] The argument regarding Leibniz is presented in Chaitin, "Digital Information: DNA/Software/Leibniz" and "Complexity, Randomness & Incompleteness," in *Meta Math!*, 47-74 and 101-124 respectively.

[202] Cf. Leibniz, §5 and §6, "Discourse on Metaphysics;" and §58, "The Monadology," in *Discourse on Metaphysics and Other Writings*, 62-64 and 127 respectively.

complexity at the earth of mathematics, the consistency of a priori space cannot overcome contingent temporal development.

What makes this relevant for the argument of the thesis, and the notion of the aesthetics in the emergent present, is that this reflects the proliferation of evolution through the adjacent possible mechanics shown by Kauffman, which progressively adds complexity to the existing network of relations; that is it progressively expands the present making it more complex, generating more information and more relations as properties that belong exclusively to the present.

In part this expansion, or divergence, was already in the argument that Leibniz presented. The mechanism that produces reality/existence (the mechanism that explains why there can be something rather than nothing) is a genetic mechanism that passes into existence that which has the larger number of consequences or implications; that is, the combination of possibilities that generates ontological emergence, in the sense that it can install links with the pattern of the existing active network and produce new possibilities for establishing new links with both existent and future emerging organisations, so that it becomes a necessary part or element of the system having emerged entirely from contingent causes.

At the same time, the image of God's mind and gaze that is supposed to guarantee the metaphysical unity of the universe for the blind monads represents a totality at work in Leibniz's logic, which cannot be dismissed. However, as was seen here in Chapter 2, any vector of convergence towards such totality is severed by the demonstration of non-integrability and the impossibility of idealisation. Thus the logic of coherence of the present (compossibility) can only be assured by the mechanism of the retroactive synthesis of the maximum implementation, the same that guarantees the success of the emergence of adjacent possibility. This determines not just how, but also what or why and the space in which possibility can emerge. That is, non-integrability turns the ontologically transcendental pre-established harmony into a logic of relevance, which expresses an equilibrium that is ecological rather than a priori. The pre-established harmony already

showed ecological overtones. Now, free from the boundary of totality, the openness or transcendental logic of the pre-established harmony, does not prescribe how or what harmony should be, rather it only demands that there be harmony; it only demands coherence. That which appeared as transcendentally convergent reveals itself as an open metastable equilibrium.[203]

The economy of simplicity, or -as Chaitin emphasises- *complexity*, is in fact an augmented economy.[204] While Leibniz champions the conservation of sufficient reason in the totality of the universe, what Chaitin highlights is that the extreme complexity of the present, though produced by the economy of compossibility which makes the most possible out of the existing building blocks respecting the commensurability of sufficient reason, quickly reaches stages of such complexity that it would not be compressible into a sufficiently economic description or algorithm. There is no formula for describing the present's organisation other than its entire history. Leibniz had almost encountered Gödel's incompleteness here. This allows Chaitin to propose that the economy of compossibility is in fact nothing other than an augmented causation or augmented reality, as the foundation of the present by constantly expanding the axiom set was for Gödel.[205]

The analysis that Gregory Chaitin makes of Leibniz's principle of simplicity points at the problem of incomputability of the space of evolution of a software. It is the same problem of incompleteness exposed by Gödel, but it highlights a dynamic aspect to Gödel's problem. Gödel had encountered an impossibility to conclude the a priori space of consistency laid out by Euclid and then Hilbert. Chaitin's emphasis instead is on the problems encountered when trying to compress the definition of such space in the simplest

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[203] Although this is outside the scope of the thesis, there are here echoes of the pure judgment *without concept* that constitutes the Kantian aesthetic judgment. Cf. Emmanuel Kant, "The Analytic of the Beautiful," in *The Critique of the Faculty of Judgment*, ed. Paul Guyer, trans. Paul Guyer and Eric Matthews (Cambridge: Cambridge University Press, 2000), 87-127.

[204] Cf. Chaitin, "Leibniz Complexity and Incompleteness," http://www.quizover.com/oer/course/leibniz-complexity-and-incompleteness-by-gregory-chaitin-videolectures, accessed June 6, 2016.

[205] Chaitin will also propose a matemathisation of evolution, where he demonstrates how all reality is an augmented reality, rather than just the few exceptional incompressible instances. Cf. Gregory Chaitin, *Proving Darwin: Making Biology Mathematical*, (New York, NY: Pantheon Books, 2012).

possible description. In this sense, and in parallel with Kauffman's argument about the non-probabilistic emergence of self-organised life (a singularity that does not take place in a space)[206] incompleteness is not only dynamic, acting as the logic of a genetic present, but most importantly it imposes to abandon an image of ontology projected as spatial, in favour of one that is based on entropy of information and has therefore a primarily temporal logic/behaviour. It is this temporal character which shifts all logic from reduction to axioms (downward) onto the emergence of possibility from local interactions as the surface (non-superficial) mentioned earlier in the chapter. This draws possibility from possibility, and draws the necessity of coherence out of the contingent emergence of possibility; actual from actual.

After complexity, incompressibility is the best result that compossibility can generate. That is, the maximum possible production of differentiation out of the simplest possible parts, one so large that it has in fact escaped the boundaries of the initial description, to generate an entirely new equilibrium on the basis of new emerged properties, heterogeneous and local; heterogeneous with the initial cause and grounded only in the present. This generates an expansion and an alteration in the identity of the system that reinterprets Gödel's incompleteness in dynamic and genetic terms.[207]

3.6 Singularity, Probability and Self-Constraints

Following the emphasis that Leibniz puts on the principle of sufficient reason, which requires that a process or choice be fully determined in all details, if all probabilities were equally probable the system would face a flat horizon of total actualisation. On the one hand, this would change little after non-integrability interrupts the commensurability of cause and effect. Anything emerging would be a singularity, but this would have happened by chance. As was seen in the second chapter, it is instead the history of the process that

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[206] Cf. Kauffman, *The Origins of Order*, 3-28.

[207] While this is outside the scope of the thesis, this evolution of the concept of incompleteness has clear implications for robotics and artificial intelligence: how can AI develop a sensitivity? Can it be creative? In fact, can a computer be an artist?

has produced emergence, which gives it coherence by constraining its evolution. On the other hand, Leibniz's compossibility explains how the emerged order is thus rather than otherwise on the basis of the economy of simplicity, which maximises the differentiation produced by the simplest boundary conditions. Leibniz rejects that this proliferation may exceed the commensurability of sufficient reason. Indeed the best universe is precisely the maximum amount of existence constrained by the law. The economy of simplicity requires that all descriptions be able to reduce or compress information. If "a formula is very complex -Leibniz writes- what conforms to it passes for irregular," which would be a patent absurdity for irregularity is outright inconceivable.[208] Gregory Chaitin has explained how incompleteness exposes the impossibility of this absolute regularity. Then the economy of simplicity constrained but not bound by totality, inevitably leads to the augmented causality described by Kauffman in the theory of self-organisation. There, starting from a random distribution, iterating random connections progressively combine accelerating towards a general network leading to emergence, which amounts to compossibility, yet without exclusion. It constantly converges without ever diverging from a totality; and it constantly diverges without ever reaching the ontological limit. This is a process passing from isotropy to singularity.[209] In this light, *finitude is a singularity constrained by its own history*. It is the finite proportion of probability, or self-constrained chance as Mandelbrot identified the problem of finitude in the present, which alone can generate coherence.

The singularity that emerges is not the random product of an actualised infinity ready to hand (whether this is God's mind or the Deleuzean interpretation of chaos as transcendental difference), rather it is a singularity that has the peculiar property of being able to emerge only from specific configurations of the process, constrained by the temporal irreversibility of such a process. In Leibniz, the "ultimate origination of things" rested on the possibility of the necessary (God as the extramundane cause), which by force of identity

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[208] Cf. Leibniz, §5 and §6, "Discourse on Metaphysics," in *Discourse on Metaphysics and Other Writings*, 62-64.

[209] For isotropy between Shannon and Chaitin, Cf. Prigogine and Stengers, *Tra il Tempo e l'Eternità*, 85-87.

exists as actual.[210] In a complex environment instead, emergence provides the ground for an open process as a retroactive necessity. Anticipating the conclusions, it is possible to see that the radical finitude of a complex regime demands that it is the differentiation produced by emergence that is taken into account for explaining the coherence of the present, rather than seeking an ultimate reason in the a priori identity or in the virtual. Ontological emergence points to Stengers' speculation upon the relevance of a choice and to Barad's ontology of diffraction. It is in fact here that ontological emergence becomes the question of mattering, as something that is able to articulate coherence without determinism or teleology and also without being abandoned to pure aleatory results.

However, when speaking of the emergence of singularity, some clarifications are necessary. While singularity is not directly emerging from total chance, the constraints are not expressing a differential, whether as a portion of a transcendent infinity as the finitude of Leibniz created monads does, or as becoming actual by diverging from a transcendental as Deleuze proposes. It is instead a process that progressively builds on correlations and includes a self-constrained degree of randomness. In fact, self-constrained chance is the only common property of the events of the mechanics of the possible. That is, actualisation and counter-actualisation are processes constrained by their own history, always moving from the correlations they have constructed. In fact, finitude, the present, is a singularity, but such singularity is a process. Singularity is not an entropic jump rising from isotropic chance/difference, rather it is constrained by its own history. The reinterpretation of Leibniz's notion of compossibility in the light of non-integrability brings forth a historical aspect of compossibility that constrains the process without binding it to the image of identity.

The shift that the thesis proposes in the light of complexity, moving from self-constraints as a primary logic that produces sense, amounts to attempt a speculative approach –as Deleuze wanted- but outside ontology. This can be derived from Mandelbrot's

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[210] Cf. Leibniz, "On the ultimate origination of things," in *The Shorter Leibniz Texts*, 31-38.

notion of self-constrained chance, or Kauffman's identification of constraints and information seen above, and from John Holland's analysis of "constrained generating procedures" in the computational approach to emergence.[211] In front of this, Isabelle Stengers constraints express a slightly different emphasis. For Stengers, constraints refer to a regime of reciprocal capture in practices of knowledge, which reflect Heidegger's event of appropriation via the heterogeneous assemblages as interpreted in the rhizomatic logic of Deleuze and Guattari (although Stengers does not mention Heidegger directly, for she is adopting the virtual ontology from Deleuze, the relational aspect of this capture is evident).[212]

Indeed, it should not be overlooked how for Leibniz creation is not a single divine act, but a progressive process. While in the divine mind this evolution of possibilities is outside time and entirely a priori, for the contingent forms of existence of historical life it is locked in the spatio-temporal grid. Finite monads are genuinely created by God in a single act; while the organisation of monads and matter, and the further organisations these will generate, are what constitutes the real world of existence that develops chrono-logically. Leibniz's God enjoys all the attributes of the idealised observer of classical dynamics. The boundary conditions, and the possibilities these set, are immediately and absolutely known to him a priori. Yet, this is an ideal knowledge that takes place in the regions of ideas.[213] The historical contingent observer is constrained by linear chronology. Leibniz develops the same argument to support individual freedom, while the divine eternal gaze has immediate access to all events a priori. In the renowned argument presented in the *Theodicy*, God can see a priori all the possible choices that Adam will make.[214] Adam's life in the divine gaze is completely deterministic. Instead, for the human Adam the future corresponds to the out of focus horizon of Ljapunov's temporal frames seen in Chapter 2. It is open and the individual

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[211] Cf. John H. Holland, "Constrained Generating Procedures," in *Emergence, From Chaos to Order* (New York: Basic Books, 1998), 125-142.

[212] Supra: the notion of constraints in Stengers will be discussed in detail in Chapter 4.

[213] Cf. Leibniz, §201, *Theodicy*, 255-256.

[214] Cf. Leibniz, "Preliminary Dissertation on the Conformity of Faith and Reason," in *Theodicy*, 75-125.

is free to choose and fully responsible for her or his choices. However, if non-integrability interferes with this dualism between an historical world and an ideal world and forever cuts off the idealisation of the divine gaze, the individual will remain forever finite and forever free to choose. The same happens to the concept of possibility. Severed from the actualisation of infinity in the divine mind, the possible is contingent and historical; that is, local and heterogeneous. Possibility can no longer express a smooth consistency as per the Euclidean or Hilbertian space, as much as it cannot exist as the limit of a transcendental Deleuzean projection. The definition of the space of the possible corresponds to the time elapsed in the evolution of contingent history. Gregory Chaitin had proposed an interpretation of incompleteness upon the impossibility of a priori computability that describes this condition of the present from the point of view of the principle of simplicity that Leibniz defended. He reached the conclusion that there is an infinite amount of complexity at the very hearth of mathematics, which instead should have guaranteed the ideal calculation sought by linear thought.[215] The demonstration of non-integrability, severing the link to such totality, exposes the finitude of the monads in full. Yet, rather than being abandoned to circulate as blind entities, monads express all the genetic character of iterating algorithms, that is their finitude is positive. In this light, it is possible to understand the difference between claiming that there is no sufficient reason, as Meillassoux does, and claiming that the reason is complex. Causality is not rejected wholesale, but only its linear interpretation. Sufficient reason is complex and does not allow integration. The ultimate, which in linear reason is essential, here becomes irrelevant for the logic of sense that organises the present.

Leibniz introduces an economical form of sufficient reason where the principle of simplicity (generating the most effect with the least investment) respects determinism and reductionism. However, even before this is severed from totality by non-integrability, the

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[215] Cf. Chaitin "Complexity, Randomness & Incompleteness," in *MetaMaths!*, 101-124. As will be seen in Chapter 4, this constitutes one of the strongest arguments against the dogmatic metaphysics reintroduced by Meillassoux, who would like mathematics to be a vector of truth that proves existence in absolute terms. Cf. Quentin Meillassoux, *After Finitude*.

economy of simplicity plays an important role in the logic of compossibility looking upward and forward rather than only pointing downward towards axioms. Passing from the "Discourse on Metaphysics," where the reductionist aspect of simplicity is presented with most emphasis, to the *Theodicy*, where the genetic aspect of compossibility predominates, the compossibility engine that generates existence is presented as the greatest amount of consequences that a combination of initial possibilities, or monads, can achieve.

The monad, as a finite amount of quality, constitutes a pattern of possibilities. However, it is paramount to notice that the divine judgment is not expressed on monads considered individually, but is always considering their plural combinations and the consequences of these combinations. It is always a problem of composites and dynamic assemblages, rather than individual independent axioms. This evaluation of the greatest consequences concerns the possibility of engendering causal consequences: if something can have causal consequences, that is if it can become cause for further events, if it can continue iterating and implementing itself with the environment, it will give coherence to the system retroactively. Then something can exist, it moves from an open and retroactive approach on the world, to a solid and networked existence rendered more robust, the more consequences it can have. A multi-consequential event is a highly relevant event. The terms in which something matters dictate the terms according to, which something exists. Compossibility presents a logic for which there can be no pure disembodied passage into existence taking place without an evaluation of its relevance.

In the Monadology Leibniz adopts a modal logic format, proposing that if something whose definition implies necessity is possible, then it must necessarily exist as actual. As was seen, necessity pulls possibility out of the metaphysical a priori into the daylight of existence (in the case of Leibniz this property is exclusively divine, obviously).[216] After complexity this logic of pure possibility is barred; it is the illegitimate idealisation that Prigogine and Stengers had decried. The a priori necessity of the pure possible is

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[216] Cf. Leibniz, §40-44, "The Monadology," in *Discourse on Metaphysics and Other Writings*, 123-124.

unattainable. The contingent, on the contrary, can raise questions upon causal consequences and relevance (epistemological, ethical, political, and indeed aesthetic). *How* something will exist, that is how it will matter, will be determining its probability of existence. The possibility of existence does not precede the contingent conditions of such existence. In fact, the claim must be turned around: *if* something matters it will exist. Instead of the necessity of a priori identity, the engine that pulls something into the daylight of existence is the compossibility regime. It is a logic that looks towards the future, rather than seeking a ground in the ontological past. Existence and sense are anchored in the ecological coherence of relevance and causal effectiveness.

The economy of simplicity works both ways in Leibniz. On the one hand, Leibniz's rationality seeks the simplest description that can explain or produce the existing universe; on the other, this economy is oriented forward, seeking the widest possible production of differentiation on the basis of the simplest initial conditions or axioms. Both encounter incompleteness, as Chaitin has shown. Yet, the simplicity of reductionism crashes against the entropy barrier generated by incompleteness; that is, it reaches Chaitin's "halting point," beyond which predictability and temporality develop at the same chrono-logical speed, therefore imposing to accept an open network whose equilibrium is metastable.[217] In this light, in the economy of simplicity of compossibility geared towards maximum differentiation of production, the series able to produce the most variations will be the one that become actual; other options are not forever lost, but simply never materialised.

This sets the terrain for the question of diffraction and relevance: a regime of irreducibility demands that the coherence of the present be constructed through

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[217] Although this is outside the scope if this thesis, it is worth pointing out how this open metastability imposes itself as a reinterpretation of the transcendental that emphasises the dynamic ephemerality of cohesion and the energy dissipation this implies, instead of the more traditional and static tension towards an unattainable a priori unity. Lyotard seems to point in this direction when he emphasises in the temporal self-perception that holds together the a priori transcendental unity of apperception, which constitutes the Kantian subject, the risk or angst that time may stop and the subject continuously perceived through this time, would vanish. Cf. Jean-François Lyotard, "The Sublime and the Avant-Guard," in *The Inhuman, Reflections on Time*, trans. Geoffrey Bennington and Rachel Bowlby (Stanford, CA: Stanford University Press, 1991), 89-107. Cf. also Jean François Lyotard, *Lessons on the Analytic of the Sublime*, trans. Elizabeth Rottenberg (Stanford, CA: Stanford University Press, 2008).

compossibility, by anchoring forward, through its effective causality as a reason for ontological emergence – as Kauffman has reconceptualised possibility. This relevance is no longer judged on the ground of an absolute. This is forever eliminated (judgment can only take place within an a priori distribution, it is at loss in front of an emergent organisation.) Rather, relevance and mattering are evaluated in relation to the pattern of the present: how can this pattern take us forward and in which way, if at all, are creative questions rather than fulfilling tasks. That is, and this is crucial, it is on the ground of an aesthetic surface, which is no longer a superficial appearance (not a surface of the senses nor an image of an object or concept) that the grounding question and answer can be enacted and satisfied. This coherence is a feedback loop logic; a logic of aesthetics, where –however- aesthetics is no longer the image of ontology. Indeed, the thesis does not develop an aesthetics of complexity, rather it explores the question of the aesthetic emergence of the present.

Two remarks can conclude this excursus on Leibniz. The first regards Leibniz's system. It would seem that the universe Leibniz describes would continue to function perfectly well also without the ultimate cause or the initial input imparted by God. Indeed addressing only the material world of existence has been the approach that has animated rational scientific investigation after Leibniz, without the need to enquire into the ideal regions of first causes. Gregory Chaitin has pointed out that for Leibniz, beyond the theological exigencies mentioned by Deleuze and perhaps even beyond Leibniz personal feelings, God provides an *initial degree of roughness* on which the logic of compossibility can act.[218] This would leave a finite and yet unbound universe, which complies with Leibniz image of contingent matter and its organisations, endowed with causality but non totalisable; thus reflecting the metastable equilibrium of complex systems.[219]

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[218] Cf. Chaitin, "Leibniz, Complexity and Incompleteness," http://www.quizover.com/oer/course/leibniz-complexity-and-incompleteness-by-gregory-chaitin-videolectures, accessed June 6, 2016.

[219] Prigogine and Stengers have developed an interesting, albeit speculative, hypothesis of such a universe. A cosmology constructed on the base of thermodynamics would see thermal death at the beginning rather than the end of the universe life. The big bang would correspond to an immense generation of entropy, that is differentiation and information, from a state of isotropic equilibrium; indeed the initial degree of roughness

The second remark concerns the claim made here that *things could not be otherwise*. This is a more delicate assertion because a regime of complex compossibility, or augmented causality, is precisely the regime where things *could be otherwise*, since it acts outside the smooth space of consistency where identity dictates the evolution of history a priori. However, as was seen, such a complex regime is one that generates its necessity retroactively through the feedback loops of its internal relationships. It is the emerging equilibrium that legitimates the necessity of possibility. On the contrary, the *otherwise* does not belong to paths that have been excluded. Rather, its possibilities have not been generated. This is radically different from possibilities that did not materialise, or did not become actual, because in complex regimes of sense, the possible emerges in reciprocity with the space of possibility; their equilibrium is constructed retroactively by compossibility.

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necessary for the universe to acquire dimensionality. Cf. Prigogine and Stengers, "La Nascita del Tempo" (The Birth of Time) in *Tra il Tempo e l'Eternità*, 142-163.

Chapter 4: Dimensionality: Finitude and the Roughness that Matters

4.1 Roughness That Matters

In the course of the argument presented in the thesis the meaning of aesthetics has changed. After the demonstration of non-integrability that which is present can no longer be identified only with that which is present to the senses, as per the accepted understanding of aesthetics. The fact that something exists cannot be separated from the determinations of its existence any more than it can ignore the genealogy that led to its specific organisation. The irreversible and rhizomatic coherence of the present makes it irreducible to material particles, as much as it bars retracing it to an origin, abstracting it towards an idea or rooting it into a ground. The present is a non-reducible singularity, a surface and yet not superficial. It does not represent, it is. Therefore, aesthetics can no longer be thought of as the phenomenological appearance of ontology, but rather as the logic of sense of such surface. In this light, interrogating thought on the basis of the categories of *relevance* and *diffraction* that Karen Barad and Isabelle Stengers propose provides the last conceptual step towards the formulation of the concept of dimensionality put forward in the thesis. The questions they raise regarding *what matters*, *how it matters*, and *for whom it matters* no longer respect the distinction between the ontological and the aesthetic, any more than they separate the epistemological from the political. This introduces an entirely new configuration of ontology and aesthetics, where all binary ontological distributions will yield to a grasping of sense and presence as continua, or *radical matter*.

Isabelle Stengers merges the epistemological questions stemming from non-integrability with Deleuze's invocation of a thought without a priori image. As was seen in chapter 2, a problem encountered inside physics has raised epistemological questions that have exploded in the demand for a reconceptualisation of ontology. Indeed, idealisation in physics is the epistemological expression of ontological identity and thus requires that science, both as the experimental practice and the mathematical formulation of theories, acts as a neutral vehicle for truth. By presenting the concept of *factish* (not a matter of fact

nor a fetish, or a simulacrum, but a relational construction) Stengers radically diverges from this interpretation and emphasises how the conceptual and material dimensions of the practice of science are intrinsically creative. This brings the notion of practice to the root of the Kantian phenomenon, exposing plurality and heterogeneity there where a thought built upon the image of totality and a practice whose syntax is idealisation could only individuate universal dimensions.

This chapter delves into this question, showing that dimensions are neither universal nor external to the circulation of sense in the present, but rather patterns of thought as much as matter, degrees of roughness, that cannot be reduced any further. In this light, it will be possible to return to the genetic logic of the practice and the factish this produces to develop two parallel questions: the first will address the reconceptualisation of ontology as complex rather than representational, adopting Stengers' question of relevance and Barad's question of diffraction as constitutive categories of ontology; while the second will develop the notion of aesthetics in a non-integrable universe of sense, showing that binary distinctions such as concept and object, essence and matter, or absolute and contingent have become meaningless categories and what Barad identifies as the material and the discursive cannot be dealt with separately. This will lead to a shift from the *ontology of Being* to the *logic of sense*; a logic animated by a radical materiality that provides an alternative terrain on which the engagement with contemporary art is possible for both the artist and the public.

4.2 Reciprocal Capture and the Questions of Mattering

Chapter 2 has introduced the distinction that Isabelle Stengers draws between the relativity of truth and the truth of the relative, or *factish*, to describe a set of conceptual and material dimensions that construct at the same time the practice of science and the image

this projects of nature as its object.[1] The reconceptualisation of dynamics attempted by Ilya Prigogine has shown that different mathematical models can be equally valid for the description of reality, and yet engender radically diverging *images* of nature and the universe. Rather than seeking a new definition of matter that can solve the problem of this dichotomy, Stengers turns to the practice of science as the primary ontological question. The notion of factish she proposes abandons absolute certainty but retains truth in relation to the practice that produces it; it names an ontological structure that is intrinsically creative and yet not arbitrary. This "truth of the relative" far from being subjective, retains a very strict logic for the construction of truth, albeit one that is specific to the dimensions of the practice and the mathematics adopted. The originality of Stengers' solution is to step out of the binary subject-object distribution of ontology and include in the definition of the object of science the political, the ethical, and –it should be added- the aesthetic relations as essential to the problem addressed by the scientist. These act as constructive constraints in the formulation of the question and expose that the discursive level traditionally associated with the disembodied abstraction of language is in fact creative. With this move, ontology is turned around and the accepted dualist structure that separates matter and material discourse is erased.

With the factish Stengers converges onto the same notion of continuity between the material and the discursive discussed by Karen Barad. This goes well beyond the demise of certainty that traumatised the first half of the 20th century. Indeed, Stengers has turned the problem around, addressing truth as an event whose emergence reciprocally and simultaneously distributes its objects and its subjects. Adopting Deleuzean ontology as a prism, she can present the emergence of the truth of the relative as a creative event that assembles the world. What is crucial in her interpretation of this event, over Deleuze's purely ontological formulation of the passage from nothing to something, is that Stengers

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[1] Cf. Isabelle Stengers, "Scientific Passions," in *Cosmopolitics*, Vol.1, trans. Robert Bononno (Minneapolis, MN: University of Minnesota Press, 2010), 1-13. This is in fact the theme that preoccupies the entire first book of *Cosmopolitics*: "The Science Wars," 1-83.

shifts the emphasis away from the eventum tantum, the expression of pure differentiation, abandoning the first ontological question (why something?) to concentrate instead on understanding how this event organises things thus rather than otherwise. Her answer is as political as it is epistemological: the practice of science is a creative event that does not represent, but rather has the ability to "dictate its own reasons" - hence the cosmopolitical project. She writes:

> In the modern sciences, we can see the invention of an original practice of attribution of the quality of being an author, playing on two senses that it opposes: the author as an individual, animated with intentions, projects, ambitions; and the author as someone who creates authority. It is not a question of a naïveté, which could be critiqued, for instance, by contemporary theories of literature, but of a rule of the game and an imperative of invention. Scientists know themselves and their colleagues as "authors" in the first sense of the term. This matters little. What matters is that their colleagues are constrained to recognize that they cannot turn the quality of authors into an argument against them, that they cannot localize the flaw that would allow them to affirm that someone who claims to have "made nature speak" has in fact spoken in its place. This is the very meaning of the event that constitutes the experimental invention: *the invention of the power to confer on things the power of conferring on the experimenter the power to speak in their name.*[2]

This quality of being authors brings an earthquake to epistemological image of truth and to the ontological certainty of facts precisely because it is not subjective. The three-fold power implicit in the experiment constitutes the logic of emergence of the factish. What is more, it is obvious that while this generates authority for its claims, it can also not exclude a certain degree of *instability* (or fragility) precisely because it is not fulfilling a space of possibility, or image of thought, laid out a priori by a concept, which would guarantee it. In other words, the truth of the relative presents an image of truth always situated and

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[2] Cf. Isabelle Stengers, *The Invention of Modern Science*, trans. Daniel W. Smith (Minneapolis, MN: University of Minnesota Press, 2000), 86. In fact, failing to gain the ability to "dictate its own reasons" and the authority to speak on behalf of nature is what Stengers laments about Prigogine reconceptualisation of dynamics, which has been ignored by mainstream physics; thereby confirming the scientific fact as an emerging event instead of the representation of the absolute and, at the same time, emphasizing the political terrain that such events have to negotiate. Cf. Isabelle Stengers, "The Passion for the Law," in *Cosmopolitics*, Vol.2, 192-204.

relational. Thus passing from an ontology of Being (representation) to a *logic of sense* (circulation). This author of a fragile truth reflects the figure of the *sophist* or, later in Stengers' work, that of Dostoyevsky's *idiot*;[3] both expressing the counter-actualisation of the installed organisation of the present towards a transcendental limit or difference, that makes the sophist/idiot resist any form of foreclosure or totalisation that would explain away the problem posed by nature. These characters mark a pause, or a withdrawal, by hinting at the transcendental limit where difference keeps the present unstable and open. On this pause, taking advantage of this instability, Stengers turns from a purely ontological counter-actualisation, to a question oriented forward; one addressing the *relevance* of the practice of science, at this point no longer only epistemological but ontological in its own right.[4] On this openness and instability pivots the entire reconceptualisation of ontology sought in the thesis that will see aesthetics come to the fore as primary. However, in this process the notion of aesthetic will also undergo a radical transformation. One begins to see that this open creativity shares many points of contact with the practice of art. To understand how this develops it is necessary to follow Stengers' argument closely.

Reciprocal Capture and Constraints - In the conclusions of *Order out of Chaos* Stengers and Prigogine emphasise the importance of demonstrations of impossibility, which produce constants that define the current organisation of the universe.[5] This is not dissimilar from the determination of finite monads "incapable of existing without limits" that acted as

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[3] Stengers borrows these figures from Deleuze and Guattari's "conceptual personae" presented in *What is Philosophy*. For the figure of the *Sophist* and the notion of humour of truth: Cf. Stengers, "Construction," in *The Invention of Modern Science*, 55-105. For the figure of the *Idiot*: Cf. Isabelle Stengers, "Deleuze and Guattari's Last Enigmatic Message," *Angelaki*, 10: 2, (2005), 151-67; and Isabelle Stengers, "The Cosmopolitical Proposal," in Bruno Latour and Peter Weibel eds. *Making Things Public*, trans. Liz Carey-Libbrecht (Cambridge, MA: MIT Press, 2005) 994-1003. Cf. also Gilles Deleuze and Felix Guattari, "Conceptual Personae," in *What Is Philosophy*, trans. Graham Burchell and Hugh Tomlison (London: Verso, 2011), 61-84, and 221n1.

[4] This was seen in the articulation of the counter-actualisation and the withdrawal of physics that this induced following the incompatibility of thermodynamics to mechanics that Stengers studied with Prigogine earlier in her carrier. Bruno Latour points out how the non-homogeneity of the image of nature encountered by science demands that Stengers find "a touchstone for distinguishing good science from bad not in epistemology but in ontology, not in the word but in the world." Cf. Bruno Latour, "Foreword," in Isabelle Stengers, *Power and Inventions: Situating Science*, trans. Paul Bains (Minneapolis, MN: University of Minnesota Press, 1997), IX-XX.

[5] As it was seen on Chapter 2, the cosmological constant that Ilya Prigogine introduces is the entropy barrier, which, like the limit posed by the speed of light, imposes an infinite expenditure that prevents immediate and instantaneous communication.

the requirement of historical existence for Leibniz.[6] However, the impossibility, or non-integrability, that is at play here reverses the terms of the problem. For Leibniz, the unity and communication of the universe were guaranteed by God as an idealised observer, which acted as the metaphysical mirror of each individual finite form of existence. While non-integrability forbids such an external observer position, Prigogine and Stengers also demonstrate that it imposes a mutual exchange, which demands that monads pass from local spectators to *actors* and engage directly with their world, no longer seen as a totality but as a local heterogeneity.[7] All description -they claim- is *dialogue*, and "this communication is subject to constraints that demonstrate that we are macroscopic beings embedded in the physical world."[8] However, this is not a linear form of communication between pre-existing participants, rather a feedback loop in which subject and object find both their place and their identity in reciprocity.

> "We start from the observer, who measures coordinates and momenta and studies their change in time. This leads him to the discovery of unstable dynamic systems and other concepts of intrinsic randomness and intrinsic irreversibility […] Once we have intrinsic irreversibility and entropy, we come in far-from-equilibrium systems to dissipative structures, and we can understand the time oriented activity of the observer."[9]

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[6] Cf. Gottfried Wilhelm Leibniz, §42, "The Monadology," in *Discourse on Metaphysics and Other Writings*, trans. Robert Latta and George R. Montgomery, ed. Peter Loptson, (Toronto: Broadview, 2012), 124.

[7] Cf. Ilya Prigogine and Isabelle Stengers, *Order out of Chaos; Man's New Dialogue with Nature*, (London: Harper-Collins, 1984), 299-300. Cf. also Ilya Prigogine and Isabelle Stengers, "The Reenchantment of the World," in Stengers, *Power and Inventions,* 33-59. In particular the section: "Actors and Spectators," which revisits the same problem addressed here.

[8] Cf. Prigogine and Stengers, *Order out of Chaos*, 300.

[9] Cf. Ibid., 300. Interestingly, Karen Barad will reach a very similar conclusion regarding the problems of entanglement and diffraction: "we too are part of the world differential becoming," she claims. In fact, the ontological argument developed here by Prigogine and Stengers and Barad's investigation will converge on the same ontological interpretation. Cf. Karen Barad, *Meeting the Universe Halfway: Quantum Physics and The Entanglement of Matter and Meaning* (Durham, NC: Duke University Press, 2007), 91.

Figure 7: Reciprocal Capture Loop:
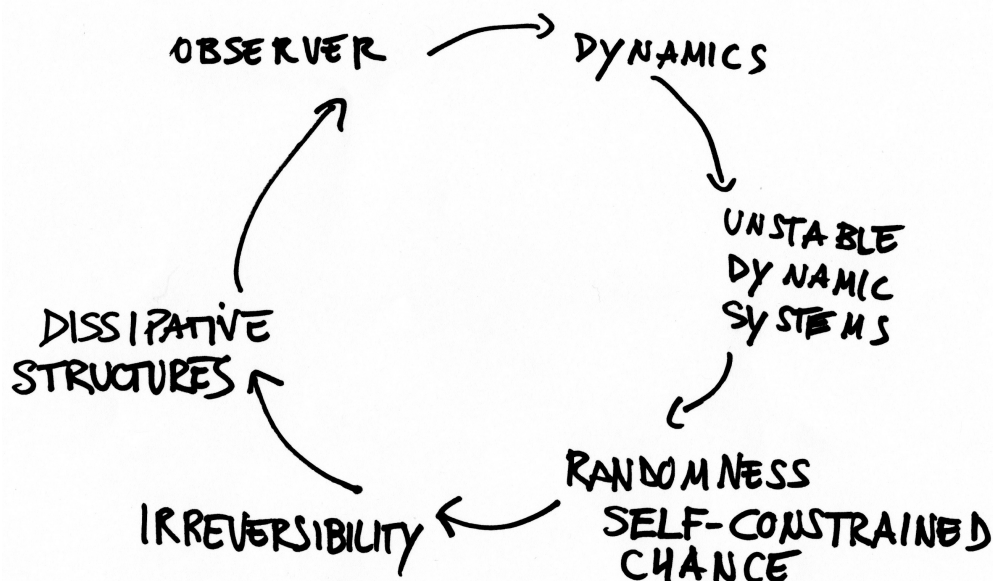
This loop installs a *continuum*. However, as it was seen in chapter 2, the moment of randomness plays a key role in the construction of this continuity. The loop does not express a totality and, at the same time, the encounter with randomness is not an opening onto total chance. Rather, as Mandelbrot had indicated, chance is self-constrained. This reveals a fractal logic as a fundamental element in this loop. The results that will become parameters for the following iterations are constrained by the previous iterations; both the history of the process and the randomness are shaped by such constraints; and the emergence of the dialogue or continuum is a singularity. In other words, this self-constrained randomness is the moment where the pattern of the present is generated; where that which is traditionally known as aesthetic takes its shape.

This loop is not a priori or deducible from concepts. Dissipative structures are not logically necessary; they develop through adjacent possibility. This model -Prigogine and Stengers clarify- does not presuppose any "fundamental mode of description […] each level

is implied by another and implies another" and none can claim pre-eminence.[10] This continuity is not installed between the observer and nature, rather concept and object find themselves on the same side of the ontological divide that was once installed by negation splitting a totality into opposites. Moreover, while the loop finds more than one point in common with the relational ground that emerges in the event of appropriation that supports Heidegger's relational identity, it does not share the same attributes of uniqueness and authenticity that characterise the Heideggerian event. In fact, it is heterogeneous; it can emerge in many local forms and its transcendental logic is in fact metastable. It is not the destiny of beings to find their proper place in this relation rather than any other. On the contrary, the relation emerges without concept (in this sense it could be said to be truly aesthetic, in Kantian terms) as much as it exists without necessity. Its self-constrained process makes its place and its dimensions.

It is on this self-constrained loop that Isabelle Stengers will be able to construct her notion of practice and the factish this produces as a new ontological approach. Moreover, as will be seen next, the elaboration of practice that Stengers proposes also provides the passage to a reconceptualisation of the emergence of sense as intrinsically material. In this light, one can see how the notion of factish speaks directly to the practice of art by moving on a terrain that generates and questions possibilities, rather than the representation of a separate and pre-existing meaning. In fact, this turns ontology inside out: all practices, not just art, are creative, functioning on the basis of a diffractive logic of relevance; while representation has no role, other than acting as a practice colonising all the others (via integrable and totalising ontology), thus reflecting a true Heideggerian *enframing*.[11]

Practice as Reciprocal Capture - The argument that Isabelle Stengers develops about the emergence of the factish inside the practice constitutes an alternative path into

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[10] Cf. Ibid., 300.

[11] For Stengers, *colonisation* is the expression of the universality that acts as the basis for judgment in modern thought. Cf. Isabelle Stengers, "Wandering About Materialism," in Levi Bryant, Graham Harman and Nick Srnicek eds. *The Speculative Turn; Continental Materialism and Realism* (Melbourne: re.press, 2011), 368-380. For the notion of *enframing* Cf. Martin Heidegger, "The Question Concerning Technology," in *The Question Concerning Technology and Other Essays*, trans. William Lovitt, (New York, NY: Harper, 1977), 3-35.

the problem of finitude and the logic of possibility.[12] After the physical constraints exposed by Prigogine and Mandelbrot, and the logic of adjacent possibility introduced by Kauffman, Stengers renews this question from the epistemological stage. Yet, these should not be seen as expressing three degrees of magnitude: the particles for Prigogine, the biological level for Kauffman and finally the social and discursive for Stengers. Non-integrability and the impossibility of idealisation found in physics are already discursive issues as much as the formulation of possibility presented by Kauffman is valid at all scales of magnitude. Both had taken a different look at the accepted distribution of matter and the dimensions that frame it. Equally, Stengers introduces "a new type of fact" different from the neutrality invoked by empiricism, which does not exist independently of the practice.[13] Her analysis exposes how the syntax of the mathematical formulation of theories as well as the staging of experimental models is not transparent and neutral, but rather thick and opaque, patterned. It has a materiality that shapes the formulation of the problem constraining both the questions and the possible answers these can obtain.[14] The level of intelligible ideas and mathematics or language, of which rationality wanted to preserve the clear and distinct purity, needs to surrender its privileged position and its authority. Karen Barad's interpretation of the phenomenon as a continuity of material and discursive practices aims at the same reconceptualisation of ontology as non-rescindable from its contingent determinations.[15]

The figure of the sophist, for Stengers, celebrates this fact as the "event that brings a new being or a new method of measurement into existence;" this is not the sign of a weakness, but that this heterogeneous creativity cannot be reduced and that the totalisation

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[12] The argument that follows is at the core of Stengers' thought and therefore addressed in several works. Here the main reference are: Isabelle Stengers, "Culturing the *Pharmakon*" and "Constraints," in *Cosmopolitics*, Vol.1, 28-41 and 42-55 respectively. Cf. also Stengers, "Irony and Humor," in *The Invention of Modern Science*, 55-71.

[13] Cf. Stengers, *Cosmopolitics*, Vol.1, 49.

[14] The argument about the importance of the mathematical syntax in shaping the image of reality is developed in Stengers, ""Thermodynamics: The Crisis of Physical Reality," in *Cosmopolitics*, Vol.1, 173-261. Cf. also Chapter 2 in this thesis.

[15] Cf. Barad, "Agential Realism: How Material-Discursive Practices Matter," in *Meeting the Universe Halfway*, 132-185.

of the image of nature and the absolute is meaningless.[16] Thereby, exposing that the intrinsic instability associated with the images and the objects of truth is not a problem of lack of robust proofs, but happens at an earlier ontological stage, stemming from the fact that practices and their truth-products are not all equal and therefore their truth-products are not equivalent (asymmetry).[17] The new type of fact is structured by rhizomatic coherence, heterogeneous and not prescribed by an a priori concept. The permanence of the emerged identity is not guaranteed, or at least not guaranteed to last unchanged. Instability implies openness.

This heterogeneity of emergence is of fundamental importance because it breaks open the consistent space, or territory of recognition, where sameness dictates the image of thought.[18] However, the speculation that Stengers proposes is not simply that of a "thought without image" (which, as was seen in chapter 3, would point towards a total counter-actualisation posing the problem of sense in pure ontological terms), but that of multiplication of images. By claiming that not all practices emerge in the same way and cohere according to the same logic, Stengers' answer points to an ecology of such practices, where the terrain is unstable, or open, and constantly renegotiated.[19] Such ecological practices are "related to the production of values" that legitimise their methods for seeking answers.[20] Crucially, these values do not transcend the problems that require them, nor they can be abstracted to the level of ideas or concepts; on the contrary, they concern the "production of *new relations that are added* to a situation already produced by a

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[16] Cf. Stengers, *Cosmopolitics*, Vol.1, 32.

[17] This does not replace the notion of a robust theory that has resisted refutation attempts, as Popper interpreted scientific discovery. Rather, proof or refutation belong to the inner logic of the space opened by each "new type of fact" that Stengers proposes, not to the construction of the fact itself. Cf. Karl Popper, *The Logic of Scientific Discovery* (London: Routledge, 2009).

[18] Cf. Gilles Deleuze, "The Image of Thought," in *Difference and Repetition*, trans. Paul Patton (London: Continuum, 2008), 164-213.

[19] Cf. Stengers, *Cosmopolitics*, Vol.1, 32. This is also what Stengers will call a *parliament* of practices, populated by diplomats rather than judges ready to disqualify as irrational all that does not comply with the unit of measure that they have installed. This is at the core of Stengers cosmopolitical proposal. Cf. "The Politics of technical Inventions" and "The Cosmopolitical Question," in *Cosmopolitics*, Vol.2, 340-345 and 351-363 respectively.

[20] Cf. Ibid., 32.

multiplicity of situations."[21] Ecology thus names an open equilibrium of heterogeneous logics, which puts the same emphasis on horizontal relationships that was seen for non-integrable systems. This describes a metastable equilibrium where identities cannot be thought of as independent of the entire system or practice; in fact, the feedback loop takes place also with the environment, beings continuously readjust themselves in reciprocity with the relationships with which they are entangled.[22] Moreover, in a true rhizomatic manner, these relations join heterogeneous scales of temporality, magnitude, speed, extension, or iteration. This constitutes a symbiotic regime of coherence, rather than a consensus built on the basis of common criteria (as instead it would have been in Leibniz's totalised universe). Stengers interprets these symbiotic entangled relationships as a "reciprocal capture."[23] That is, reciprocity both "creates relationships" and endows them with stability by finding "heirs" who can share the attributes of these established relations.[24] This shared inheritance takes the reciprocity past Deleuze and Guattari's rhizomatic double capture and past Heidegger's event of appropriation, on which it is obviously built, and roots it in the possible consequences that these new relationships may engender: a relationship can be established if it has consequences. Like Kauffman's ontological emergence, it needs to be causally relevant in order to develop coherence. This is because coherence is not internal to the fact/being but concerns its existence in an environment. What is more, a relationship posed in these terms does not express a unitary ontological ground shared by all emerging events, but rather it is heterogeneous in its forms of capture as well as in the production of potential consequences. That is, it produces the values upon which it is judged in the same exchange that establishes the relationship. The fact that it produces emerges as a singularity. Relevance is thus not another form of causality. Stengers is not interested in linear consequences or the possibility of repetition. Rather she is concerned with the potential generation of possible alternative futures introduced by the hesitation of the

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[21] Cf. Ibid., 33.
[22] Cf. Ibid., 34.
[23] Cf. Ibid., 35.
[24] Cf. Ibid., 35-36.

sophist. Here lies the importance of the concept of relevance as the ethico-political as well as the aesthetic risk that the practitioner, the scientist or the artist must be willing to take.

It thus becomes evident how the interpretation of the image of the sophist that Stengers puts forward names a *constructivist* interpretation of scientific practice that is fundamentally creative. The fact and the observer emerge correlated and position themselves as object and subject in this affirmative event, which they cannot transcend.[25] In so doing, emerging constructive practices subtract themselves from the hierarchical organisation of space laid out a priori by ideas or expanding in the echo of the virtual. They are not the implementation of a theory, rather they organise space but not by acting as a priori and independent structures. Their logic is both relational and self-constrained.[26]

This conceptualisation of the fact is not restricted to scientific practices. By reinterpreting the problem of scientific truth as a heterogeneous and local construction, Stengers turns it inside out, presenting it as an intrinsically ontological problem. It is no longer an issue of representation or of its frustration, but rather it concerns the event of sense. In this light, one can begin to see how the hierarchy that had traditionally positioned artistic practices at the periphery of ontology, relegated to sensorial appearance or semantic representation, loses meaning and the distinction of concept and matter collapses.

Constraints - The kernel of the argument regarding the emergence of a new type of fact is that for Stengers reciprocal capture is an event. It marks a claim, or even a marvel: "an *It works*!"[27] Relations are established, bodies extended, territories made, economies installed, and questions are inextricably related to their answers in simultaneity with the emergence of the criteria needed for the work of this new coherence. Circulation comes to the fore simultaneously with the terrain on which it moves. Practice does not take place but makes place; or better it *makes sense*.

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[25] At stake here are problems such as the independent existence of the neutrino. Cf. Stengers, "The Neutrino's Paradoxical Mode of Existence," in *Cosmopolitics*, Vol.1, 14-27.

[26] Cf. Ibid., 40.

[27] Cf. Ibid., 42.

The loop between observer and nature, or the reciprocity between beings and the epistemological or political environment, make both the values and what these values sanction as valid, in a process of emergence whose category is speculation rather than recognition.[28] With this, Stengers seeks an answer to Deleuze's invocation of a "thought without image;" a thought that could take place outside the light cone shone by a priori identity. For Stengers, this speculation develops the question that is encountered when an event-based ontology has to meet the epistemological demands of science; that is, how to avoid foreclosing the "abstract" and open character of this *it works* as a coherence that emerges outside the image of thought.

The dimensions and the logic of the production of the fact that something works depend on the *constraints* that shape the landscape of its emergence. As non-integrability has shown, these cannot be provided by concepts or idealised forms, but depend on the process. Now Stengers pushes this interpretation even further. Constraints are not simply deterministic material conditions accumulated in the history of the process, degrees of freedom that albeit local and contingent are liable to be interpreted as retaining an element of linear causality. Constraints are instead the demands set by these conditions; demands that need to be satisfied and yet –Stengers says- the way in which these demands are to be satisfied "remains by definition, an open question."[29] That is, this openness is the space of the social and relational challenges raised by hesitation and wonder. The *it works* must not be thought of as a universally recognisable discovery, rather as the emergence of a coherence structured on the acceptance of the community within which the new challenge is proposed. It is on the protection of this openness, on the resistance to a future dictated only by statistical probability, that the purely ontological question of truth becomes one that concerns the *relevance*, or -as Barad puts it- *diffraction*, of the contingent criteria that generate the coherence of this new type of fact. This *openness* accompanies possibility and works in combination with the conditions. These provide a necessary initial roughness, but

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[28] Cf. Deleuze, "The Image of Thought," in *Difference and Repetition*, 164-213.

[29] Cf. Stengers, *Cosmopolitics*, Vol.1, 42-43.

at the same time are not sufficient to determine emergence. Constraints function precisely in this openness stretching in the distance between necessary and sufficient cause.[30] Crucially, they mark it as self-constrained chance, which is both holding the feedback loop together and preventing it from closing into a mirror of identity. In fact, in their demand to be answered constraints generate the possibilities for moving forward; they are creative. Practice, in other words, is creative rather than a transparent vehicle for representation of information. There is more at stake in this reciprocity than what Popper had called *plastic control*. In fact, plastic control still acts as a form of judgment in function of a whole; not a solid concluded totality set a priori, but nevertheless an organisation that takes itself into account as a continuous organism. What Stengers aims at is precisely resisting this totalisation and keeping a plurality from converging onto a unity, presenting instead a plural and metastable ecological equilibrium.[31]

Reciprocal capture thus names a practice that takes place outside the a priori concept-object or subject-object distribution. It is a *practice without concept* that would point at the judgment without concept of the Kantian aesthetics. Yet, Stengers' proposal goes in the opposite direction of this disinterested judgment. Indeed, it could be said to point to a new grasping of aesthetics, as a coming to presence which still retains the marvel at the emerged coherence of the *it works*, but at the same time cannot detach its logic from its consequences any more than it can ignore its history. Moreover, such judgment of coherence is not limited to the sensorial presence of the object, but extends to the non-material ethical and political resonances that this may have. In the loop between these openness and interest plays the entire reversal of ontology that Stengers and Barad operate. The anchoring forward of relevance, or diffraction, that presents ontology

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[30] This splitting of causality was identified by Kauffman in the concept of adjacent possibility seen in Chapter 3. The same openness of conditions that cannot necessitate emergence was described by John Holland as one of the main traits of complex processes. Cf. John H. Holland, *Emergence, From Chaos to Order*, (New York, NY: Basic Books, 1998).

[31] Cf. Karl Popper, "Of Clouds and Clocks; An Approach to the Problem of Rationality and the Freedom of Man," in *Objective Knowledge, an Evolutionary Approach* (Oxford: Oxford University Press, 1983), 206-255.

necessarily engaged and committed, interested that is, and in circulation rather than abstract and static.

The Questions of Mattering - Complexity clashes with the assumption of pure existence abstracted from contingency to which instead ontology constantly returns. Karen Barad addresses this problem in even more explicit terms than Stengers. For her the question concerning how things can be thus rather than otherwise is a question of "patterns of difference that make a difference," or as she names this concept, *diffractions*.[32] Her departure point, as Stengers', shares the criticism moved by Deleuze against a priori concepts that impose a logic of recognition within the pre-existing coordinates of identity; thus producing the double effect of mapping sense on the model of a transcendent or transcendental image as a "mirror of sameness," and projecting ontology through a spatialised and visual metaphor.[33] Diffraction is opposed to the reflection that the image of thought requires. It is always plural. It is a phenomenon that is not concerned with pure or absolute beginnings or with converging onto a totality, but with contingent interferences that have casual consequences and generate new interferences. It is the act of contingent determinations on contingent determinations, or roughness on roughness; a phenomenon of *superposition* and resonance where more difference and more information are generated. Diffraction echoes Kauffman's passage from actual to actual in the logic of adjacent possibility as well as the augmented causation studied by Ilya Prigogine.

However the similarity with Deleuze's speculation ends here. Diffraction is not difference. Barad considers the potential open multiplication of the contingent effects of diffractions as fundamental for the problem of ontology. The question she poses is not pure, disembodied but always engaged. Deleuze instead frames the problem of sense as if answering the pure ontological question why something rather than nothing, or radical difference, could also provide a solution for all the subsequent variations of *thus* or

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[32] Cf. Barad, "Diffractions: Differences, Contingencies, and Entanglements that Matter," in *Meeting the Universe Halfway*, 71-94.

[33] Donna Haraway rather than Deleuze is Barad's direct reference for this problem. The argument is however the same. Cf. Ibid., 71-72.

otherwise. Equally, diffraction patterns never return to a transcendental image from which they would initially diverge, therefore it cannot be assimilated to the ontology of the virtual. The value of Barad's input instead is to warrant all the importance and relevance of the chrono-logical distance generated in the augmented causation of complex processes.

Barad, sharing the same concern that Stengers raises in the cosmopolitical question, distinguishes between asking if a given configuration or conceptualisation *matters*, and the questions concerning *how* it matters and *for whom* it matters.[34] This translates the difference between the why something rather than nothing question and asking how things came to be organised thus rather than otherwise. When the question of mattering (*does it matter?)* is articulated beyond the purely ontological existence into *how it matters*? and *for whom it matters?* immediately the aesthetic-epistemological (how) and the ethical-political (for whom; who is interested) present themselves as part of the initial question that pretends to act in the smooth space of absolute existence. This amounts to a *colonisation*, as Stengers puts it, of contingent practices precisely through the denial of their specific relevance, where ontology arrogates only to itself the capability of supplying a satisfying answer for the problem of sense and coherence - as if pure explanations could precede the contingent and the historical, and dispense with it as superficial and irrelevant. In fact, ontology posed in these terms is nothing but an exercise of reduction. Non-integrability has shown that this is an arbitrary idealisation. Barad exposes how this also implies a political distribution. The aesthetico-epistemological *how* it matters and the ethico-political *for whom* are the dimensions of existence that participate in the constitution of the fact or phenomenon at fundamental level (as probability did in Prigogine's reconceptualisation of dynamics).

Barad takes this further reaching the core of the notion of practice. By articulating the question of relevance in how/for whom, she points out that this how matter matters and for whom it matters are degrees of roughness that cannot be integrated, or otherwise

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[34] Cf. Barad, *Meeting the Universe Halfway*, 87.

broken down into independent elements, which would return the problem to the pure, disembodied and abstract ontological question of existence as a binary yes/no which reflects the why question. In fact, how and for whom mark "primary ontological units" where material and discursive practices cannot be separated.[35] These are not relations stretching between points (pre-existing or reciprocally transcendental as in Heidegger) but patterned *continua*, which cannot be reduced or abstracted to something disengaged from the contingent heterogeneity of languages, technologies, or logic of modelling. Non-integrable ontology demands that sense be interrogated via diffraction, rather than through reduction or idealisation. When the question *does it matter* is articulated in how and for whom it matters, one enters a plurality of questions that demand in multiple directions at the same time. Diffraction *interferes* with the very ontological question that seeks a unique or ultimate answer. In fact, a non-integrable ontology does not permit any other form of interrogation other than interfering with the complexity or roughness of the contingent existent and inhabiting the diffractive reactions, trying to become attuned to their relevance.

Barad's insistence on this point directly resonates with the artist's concerns. An ontology structured on identity cannot but assume that "practices of representation have no effect on the object of investigation," thus making any language neutral and transparent.[36] In reflection as the mode of a thought structured as the image of an a priori identity, the adoption of a visual metaphor derived from geometrical optics entails a "spatialised grasping of ontology" where the recognition is always converging on a totality. Yet, as long as the relevance of this metaphor is not acknowledged, the spatio-visual image of thought will be considered as the absolute manifestation of thought and the relevance of the syntax of the language adopted in shaping sense will be ignored. Indeed, the metaphor of geometrical optics "is devoid of any ontological commitment" about the nature of the

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[35] Cf. Barad, "Agential Realism: How Material Discursive Practices Matter," in *Meeting the Universe Halfway*, 132-185.

[36] Cf. Barad, *Meeting the Universe Halfway*, 87.

language or medium (light in this case).[37] This ontological commitment, precisely because it demands engagement and assumption of responsibility, cannot be pure existence, but needs finitude for functioning. In fact, pure ontology would be nothing but disinterested aesthetic contemplation. In other words, diffraction means that the *questions of mattering can only be raised by becoming attuned to matter*; but, crucially, *matter* cannot be identified only with what is materially present, particles, with tangible mass as a static and inert fact, but must include the relations it is embedded in and the consequences of interactions. Moreover, diffraction should not be grasped as replacing the old visual metaphor with a new one. The fact that diffraction "attends to specific material entanglements" makes it intrinsically heterogeneous and local. Barad makes this point with great emphasis: "if diffraction is to serve as an important metaphor for differences that matter, it is crucial that we pay attention to the kinds of differences that different understanding of diffraction evoke."[38]

Indeed avoiding turning diffraction into a new metaphor, and emphasising a speculative prism, the question concerning ontology is reversed. For Barad, reflection and recognition construct an optical geometry of Being around sameness that takes vision and Euclidean space for a model, which is posed as absolute.[39] Barad's conceptualisation of diffraction instead, is not only referring to a phenomenon that is physical, without being visual, a material pattern. But escapes recognition on another count. As a phenomenon that concerns the diffusion of waves and the nature of light, thinking through diffraction imposes to take into account their contingent properties and behaviour. Thus, showing both that a language is fundamentally material and that this materiality is fundamentally relevant for the different images of matter and the universe of sense it projects. It is this counter-actualisation of a unique image imposed as absolute that shows that the material cannot be separated from the discursive any more than the matter-medium can be separated from the

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[37] Cf. Ibid., 85.
[38] Cf. Ibid., 88, 419n25.
[39] Cf. Ibid., 87-91.

sense-meaning in art-work-practice. The ontological layer cannot be abstracted from the epistemological distribution or from the aesthetic phenomenological appearance.

Barad explicitly states that practices of knowledge are material. "The world materialises differently through different practices" and "phenomena are not ephemeral" or merely phenomenological events, therefore reducible to simpler independent elements that would constitute their real matter, but are "objective."[40] The tangle of their relations exists as a continuum, not a line joining points. Rejoining Stengers' reciprocal capture and constraints, one begins to see that while practices are material, it is the notion of materiality that is changing following non-integrability. As seen in Chapter 3, Kauffman had already indicated that constraints *are* the information implemented by the system, rather than being its expression. Here these are extended to the relations that make the object or the present what the object/present is. This introduces an interpretation of ontology as inherently contingent. Which is better named: *sense*.

Practices of knowledge making are not representation.[41] Crucially, they "are specific material engagements that participate in (re)configuring the world," producing specific worlds configurations; they "make knowledge, make facts, make worlds" *make sense*.[42] Therefore, accountability and responsibility are part of any decision to approximate through one model/metaphor or another, which makes the ensuing configuration not simply phenomenological, but also aesthetic as much as ethical and political. It makes worlds through the engaged commitment of the decision.

In this interpretation of the practices of knowledge as creative-genetic, science is tangent to art as much as it is to philosophy. Yet, not because they would be equally distant from some real object on which they would transcendentally converge. Rather in their logic the coming to presence engendered by the specificity of a practice "makes worlds."

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[40] Cf. Ibid., 89-90.
[41] Cf. Ibid., 90.
[42] Cf. Ibid., 91.

Practices are "dynamic," in the sense that they involve and engage with each other;[43] they indicate the material-discursive nature of "boundary drawing" and also constitute distributions, exclusions, accountability and responsibility. Thus enquiring about them means questioning their histories; as will be seen this is a genealogical question. Furthermore Barad emphasises the plurality of this contingency. It is not matter on an ontological practice, unique, universal, or authentic, which would take place as the relation subject-object or the eventum tantum; rather, of reciprocal and multiple practices in relation and diffraction among each other.[44] Once again it is a matter of roughness on roughness rather than beings and Being.[45]

The Heterogeneous Constraints and Genetic Practices - The articulation of the question of relevance as mattering produces an expansion of the logic of coherence to include material correlations as well as immaterial relationships as part of the same self-constraining pattern. What does not have *tangible mass* does nevertheless matter; it is both part of the object as a fact and it is intrinsically material and sensual. That is, the binary distinction between material and immaterial, practice and theory, matter and concepts, history and possibility is erased. The fact and its constraining relations, or indeed dimensions, constitute a continuum that belongs to the universe of sense. However, relations do not become part of the facts and matter wholesale. How they participate to the emergence of facts in a regime of reciprocal capture is determinant for the genetic logic of the practice. Barad's articulation of the question of mattering emphasises how the specificity of constraints is essential in the loop of reciprocal capture and therefore how a self-constrained practice is intrinsically genetic. The fact that the demand that constraints "must be satisfied" and yet leave how this satisfaction should take place as an open question, as

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[43] Cf. Ibid., 93.

[44] Cf. Ibid., 92-93.

[45] Here it progressively becomes clear how diffraction differs radically from the quasi–transcendental refraction adopted by Bergson as a way out of the abstractions of metaphysics and the virtual. Cf. John Ó Maoilearca, "Forget the virtual: Bergson, actualism, and refraction of reality," *Continental Philosophy Review 37*, (2004): 469-493.

Stengers claims, is precisely the matter of diffraction.[46] This analysis of the questions of mattering brings to light a logic of divergence that leads Stengers to emphasise how practices are genetic but not equivalent in how they create sense. This genetic divergence, which is intrinsically material, is shared by the logic of emergence of the scientific fact and by the production of sense in contemporary art practices.

Constraints are the demands set by the contingent patterns emerging from superposition. They mark and shape the passage from an existent organised distribution to the possibilities this entails. Their openness is not total, but self-constrained by the existent. Yet the demands they raise are open and oriented forward. Constraints are not an expression, let alone a representation, of causes, but point to the consequences of their implementation. Here the image of anchoring forward introduced in the previous chapter shows its full creative meaning: the satisfaction of the demands raised by constraints leads to the emergence of organisation and distribution. The openness of these demands is the space of the aesthetic, epistemological and political questions of mattering, which imply creating and taking responsibility at the same time. That is, the demand that constraints express is a judgment of ecological coherence that opens and directs reciprocal capture to the environment, towards an equilibrium material as much as social, material as much as relational, material as much as immaterial. It is this process of actualisation, which casts the question of sense in the light of relevance, rather than deriving it from a line of direct causality, reduction or idealisation.

This openness that demands but does not prescribe, means that the notion of constraints can only be addressed and satisfied ecologically. For Stengers how a practice matters cannot be addressed without also asking how it is relevant for the "heterogeneous set of those who accept to be shaken up, modified, interested by it."[47] That is, *how* it matters coincides with *for whom* it matters. Reciprocal capture binds together in one feedback loop facts, the specific practices and the interested participants in a continuous ontological

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[46] Cf. Stengers, *Cosmopolitics*, Vol.1, 43.

[47] Cf. Ibid., 43.

organisation, which "materialises a real history" by satisfying the three questions as a continuum. This must not be grasped as a new form of convergence onto a unity. The ecology that Stengers describes is precisely one that does not conclude (that is totalise and close), but is set to "rework the implications" of that which is emerging and presenting itself as a problem. The equilibrium this ecology aims to reach remains metastable and preserves the heterogeneity of the practices.

The constraints of the fact produced in reciprocal capture act both as *obligations* and *requirements* for the interpretation of emergence.[48] They are "abstract" until the satisfaction of their demands actualises them in one or another form.[49] Constraints pose a problem that those who encounter it are obliged and required to interpret. Stengers recasts in these *open* terms the focus on what "is given in the given" that Deleuze saw as the generator of thought.[50] Thus emphasising the productive aspect over the abstract causality (difference) that Deleuze had in mind.

Obligations first concern interpretations. The value of the experimental fact consists in its ability to convince or "obligate practitioners to agree about their interpretation," because this interpretation matters and the debate that may ensue is constitutive of their meaning.[51] That is, facts are relevant and the satisfaction of their obligations may engender a genealogy. Obligations concern the environment, and are epistemological as they are political. Requirements instead, concern the phenomenon and the way in which this is "mobilized" to become a "*reliable witness.*"[52] Requirements reflect how things matter, while obligations address the interested parties in the question of mattering (for whom).

In this light it becomes evident how constructed facts are not equivalent in the description of reality they address. Rather, the heterogeneous logic of their emergence and

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[48] Cf. Ibid., 49-50.
[49] Cf. Ibid., 51.
[50] Cf. Deleuze, *Difference and Repetition*, 175-176.
[51] Cf. Stengers, *Cosmopolitics*, Vol.1, 50.
[52] Cf. Ibid., 50.

installation describes a "topology," Stengers writes.[53] The dimensions of organisation and distributions are not absolute but contingent and local, dependent on the specific set of obligations and requirements of the given phenomenon. This defines not just constructivist practices, but rather an entire constructivist ontology. Then when the feedback loop comes around, depending on the definition of reality and on what is asserted as value, requirements and obligations are specified and derive their meaning. Obligations, which pertained to the domain of political dialogue, the relational element of the event of emergence, reveal themselves as belonging to "the register of creation;" relations that constitute an "irreducible dimension" circulating on the surface of the event/phenomenon. Conversely, requirements, which concerned the phenomenon and its effect on the world, "present the problem of a possible stability of that creation" becoming political.[54]

This exposes how constraints are heterogeneous and do not follow the same logic across sciences. Their open demands constantly rework the methods and the relation with interested parties and the position of values. Assuming the opposite would amount to an arbitrary idealisation. The heterogeneity and locality of constraints; their being specific to the practice from which they emerge and, at the same time, being the specific relationships that the demands of this practice establish with the environment where it is active, make the fact emerge as a singularity; "autonomous" as Stengers says.[55] However, this autonomy is not in reference to a finality, making emergence gratuitous. Although, as was seen, reciprocal capture names a practice without a priori concepts, what takes place in the emergence of coherence is not aesthetic disinterest as in the Kantian contemplative judgment, but precisely the opposite. The form of this coherence is not only a phenomenon presented to the senses; it is aesthetic in the sense that it makes presence, but it does so by taking into account the political, ethical, and epistemological implications of its emergence. Thus it becomes evident that in a process that develops along these self-

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[53] Cf. Ibid., 52.
[54] Cf. Ibid., 53-54.
[55] Cf. Ibid., 46.

constrained dimensions, sense is generated heterogeneously and its meaning and value can only be addressed and judged inside the specific dimensions of the space in which it has emerged. Meaning is possible only within the rules of the grammar that supports it. Ontological abstraction or generalisation is equivalent to semantic destruction.[56] In this light, idealisation is a political act/decision that tries to smooth down differences into a homogeneous unity.[57]

Practices emerge as feedback loops of demands and constraints. They "incorporate, as constitutive dimensions, the criteria, imperatives, and modes of judgment that […] they had to take into account."[58] Thus they are never acting as neutral vehicles, translations of the thing in itself, but are heterogeneously and autonomously creative.[59] Likewise, constraints in as much as they are relevant in shaping a specific material present, a present that matters, express *material* dimensions. It then becomes clear how the new type of fact generated in a practice of reciprocal capture cannot be simply thought of as a new neutral fact of empiricism. Indeed, it is impossible to have an independent fact, expression of an integrated reality. Stengers concludes that any practice is a form of coherence that depends on simultaneous rhizomatic milieus intersecting and participating; yet this intersection coincides with a "principle of non equivalence" of practices in front of the description of an absolute reality.[60] In fact, ontology is turned around. Continuity takes over from the representation of a thing in itself (transcendent or transcendental). As was seen for non-

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[56] While outside the scope of the thesis, here one must remember Wittgenstein. Indeed this impossibility to separate meaning from language, that is to abstract a concept from contingent circulations, was Wittgenstein's main concern. The argument about how meaning is possible only within the rules of the grammar that supports it is particularly relevant here. Cf. Ludwig Wittgenstein, "Proposition and its Sense," in *Philosophical Grammar*, ed. Rush Rhees, trans. Anthony Kenny (Berkley, CA: University of California Press, 2005), 39-240.

[57] Cf. Stengers, *Cosmopolitics* , Vol.1, 47.

[58] Cf. Ibid., 47-48.

[59] Meillassoux's trust in mathematics as the guarantor of an absolute or "ancestral" reality *out there*, acting as the metaphysical ground valid for all events, crashes against the "principle of non-equivalence" introduced here by Stengers. This blind trust in mathematics is at the core of *After Finitude*. Cf. in particular Quentin Meillassoux, "Hume's Problem" and "Ptolemy's Revenge," in *After Finitude: An Essay on the Necessity of Contingency*, trans. Ray Brassier (London: Continuum, 2009), 82-111 and 112-128.

[60] Cf. Stengers, *Cosmopolitics*, Vol.1, 54.

integrability, with the emergence of phenomena on the basis of relations and genealogies, as Stengers poses it, the possibility of the noumenon becomes irrelevant.

In fact, with the truth of the relative and the constructive practice Isabelle Stengers turns non-integrability into a *positive* (positive ontology). Finitude is not the passive product of limitations. The practice emerges. The fact, rather than being simply limited to the present by the boundary posed by Ljapunov's windows, and therefore suffering the inability to be re-conduced to origins or axioms, is instead entirely oriented forward. As with Kauffman's adjacent possibility, the logic that confirms its success is in the relations that articulate its implementation with the environment. It is here that Stengers can draw a link between the process of emergence in complex processes and the speculative approach inspired by Deleuze's ontology. Emerged self-organisation is presented in a manner converging with the encounter with "that which is given in the given" that Deleuze invokes against the logic of deduction.[61] However, Stengers pushes this further than Kauffman's material and mechanistic image of the emergence of possibility. She shows that the challenges associated with accepting and implementing the fabricated fact (factish) and its relationships with the environment or milieu are the reasons why a practice produces facts *thus* rather then *otherwise*. Relations constitute the constraints that mark the specificity of a given event of emergence. They constitute its determinations, its qualities and its heterogeneity with respect to other events of emergence. Yet, constraints are not marking a differential from the pure possibility represented by the plane of immanence in Deleuze and Guattari's rhizome, rather they are positive qualitative patterns constructed locally. The finitude, which for a non-integrable interpretation of Leibniz engendered the determinations that permitted the passage into existence, expresses here all its genetic power.

Accepting fragility and developing the notion of "truth of the relative" has brought Stengers to develop a new ontology. The event of emergence is complex and therefore fundamentally materialist and dynamic. However, it is the very *notion of materialism that*

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[61] Cf. Deleuze, *Difference and Repetition*, 175-176.

has undergone a radical shift in this process. Prigogine's reconceptualization of dynamics had shown that matter cannot be described as inert, and that the correlations between particles and process are equally relevant in its organization, behaviour and identity. Likewise, matter and that which matters for the logic of sense cannot not be considered only as the *tangible presence* of givenness, it must include all the *intangible* but equally present and equally *relevant* relations and epistemological structures that circulate. Aesthetic is not limited to the senses but includes, or indeed is, the logic of sense; an *aesthetic of the factish* has nothing to do with *simulacra*. This reconceptualisation of matter also has deep implications for the notion of practice. Both, will be seen, lead to a radical reconfiguration of the relationship between aesthetics and art practices.

4.3 The Turn, Breaking the Equivalence of Ontology and Aesthetics

Heterogeneity and Aesthetics - The "principle of non-equivalence" that Isabelle Stengers introduces to name the heterogeneous logics at work in different practices shows that non-integrability and augmented causality belong not only to matter as the object of physics, but *matter* also at the level of the circulation of sense. In self-constrained processes, constraints constrain locally and heterogeneously. As the sensitivity to initial conditions generates divergent evolutions in chaotic behaviour, equally with the non-equivalence of practices in a regime of reciprocal capture the iteration of heterogeneous self-constrained processes leads to different organisations of sense, rather than representing the identity of the same. This frees the process from embodying a priori concepts and describing a homogeneous and unitary world, and brings to the fore –as Stengers pointed out- the autonomy of the practice, thus breaking the absolute equivalence of practices of knowledge and interrupting the linearity of representation. This interruption reflects non-integrability, but rather than emphasising finitude as a limit it brings to light its genetic logic. Indeed, practices emerge as *continua*, patterns of sense whose dimensions are genetic.

A thought whose image takes idealisation as its primary logic cannot but assume that the language that describes Being has no effect on its description and that the practices of investigation have no effect on their object. The passage to the ultimate is grasped as smooth and the mediation would be nothing but the conservation of identity, causality and information. Yet, a plurality of languages breaks open the absolute representation of the object or the world. The fact that practices of reciprocal capture do not express an equivalent logic and have a disruptive effect on the homogeneous representation of the object of knowledge radically upsets the fundamental structure of ontology projected as a passage to the ultimate. Barad's question regarding the modes of mattering points to this very problem of divergent practices and genetic materialisations of worlds of sense, thereby exposing a radical indeterminacy in what was supposed to be a clear and distinct intelligible homogeneity.

Let us return for a moment to the problems encountered between dynamics and thermodynamics. Different mathematical models project different images of reality. The mathematical syntax is neither inert nor neutral; the practice is not transparent but dictates its own constraints and in so doing actualises the universe in a specific and local order. On the other hand, assuming that there is one language that can express its object absolutely implies that there is an independent object to which this language has full access and, at the same time, it entails the disqualification of other languages as unable to convey information correctly. Likewise, if there is an absolute concept/object that is supposed to be expressible, then there must be an absolute language that expresses it immediately and in a pure manner without gain or loss of information. This is the traditional role ascribed to mathematics that Meillassoux and Badiou want to resurrect.[62] For what concerns practices not as pure as mathematics, the assumption of an absolute object demands that different formulations converge by representing compatible portions of the same truth, ideally

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[62] Meillassoux pushed this equivalence as far as indentifying what mathematics can say (the domain of mathematics) with what the domain of possibility, effectively resurrecting the smooth a priori space that was shattered by Gödel demonstration of incompleteness. Cf. Meillassoux, "Ptolemy's Revenge," in *After Finitude*, 112-128. Cf. also Alain Badiou, *Being and Event*, trans. Oliver Feltham (London: Continuum, 2005).

totalisable into one continuity. However, if different practices constitute different platforms for staging questions and refuting objections, leading to diverging but equally valid images of matter and nature (as Prigogine has shown), the absolute representational value of such language vanishes and the homogeneity of the object (or the concept) also crumbles as yet another arbitrary idealisation. This is the finitude that Quentin Meillassoux wanted to overcome in his attack against a correlational grasping of sense by upholding mathematics as the absolute language able to reach the "ancestral" independent object; a language also able to name what is possible a priori. Prigogine and Stengers have shown the intrinsic impossibility of such language for both science and thought, as well as showing that this finitude is not a limit but the very condition of sense.

The import of this interruption is as disruptive for ontology as it is relevant for art. The arbitrary idealisation of a pure code that dismisses its materiality *anesthetises* language, as well as matter, in function of a pure code or concept. This makes art impossible. Reductionist ontology has no place for the sensual and poetic logic of artistic modes of operation. At the most, it can contain art as captured in a discrediting hierarchy: That which can be said in multiple ways is placed on the lower rungs that lead to truth. Diverging languages demand disqualification in order to uphold the principle of non-contradiction. Thereby, art, in whichever form it is encountered, is precipitated to the level of obscure and confused perceptions and permanently excluded from a legitimate engagement with questions of sense. This hierarchy that was at the core of Hegelian aesthetic theory is not overcome in contemporary practices, though not immediately rooted in a specific medium. Contemporary practices and criticism that overemphasise the semantic role of the work and concentrate only on a hermeneutical approach reduce art to visual communication, sensorial illustration of concepts or anthropological issues. This dismissing of the materiality of matter amounts to ontological *forgetting*; a censoring of the

sensual and essential presence of matter and of the demands this expresses that mark both matter and art *thus* rather than *otherwise*.[63]

In fact, art is a practice where *thus* cannot be swapped for *otherwise* without radically changing its sense, or destroying it altogether. Thus and otherwise are categories as radical as something versus nothing and, as was seen in the previous chapter, are the condition for the passage from nothing to something. The questions of relevance and mattering raised by Stengers and Barad bring to light that without contingent forms of presence and expression, such practices not only would not be art but would also be nothing else; they would be nothing, or better they would not be. This does not make art a special case in the space of an eternal and transitive property of commensurability. On the contrary, the multiplicity of diverging languages forbids the homogeneity of ontology. However, this does not amount to anew empirical proof leading to a new truth, rather it belongs to the demonstrations of impossibility that keep the system open.

The great advantage of Stengers' emphasis on constraints is to shift the focus from the object to the practice. That is, from a problem articulated as the success or the failure of knowledge as taking place between subject and object, to the active and generative logic where both subject and object find a place and make sense. This abandons the ontological structure built on concepts, which would make the practice an exercise of generalisation and recognition, for a heterogeneous logic of emergence, which cannot be reduced to any common denominator and finds legitimisation and meaning locally. What is more, this also overtakes Heidegger's relational ontology, which is still pointing at one ontological relation both authentic and unique. Opposed to the absolute one finds not contingency but the heterogeneous. The delta of languages encountered in physics does not leave science, or

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[63] Forgetting this material and sensual presence was the critique Luce Irigaray' moved against Heidegger for having failed to undo logocentric ontology. What is been discussed here pushes the criticism further. The question can no longer be asked in terms of the binary opposition of one matter or body versus abstract rationality. What is at stake instead is precisely the problem of dwelling in a heterogeneous plurality where the relevance of matter varies depending on the practices and their milieus. Cf. Luce Irigaray, *The Forgetting of Air in Martin Heidegger*, trans. Mary Beth Mader (Austin, TX: University of Texas Press, 1999).

art and philosophy for this matter, drifting in a sea of arbitrariness. Rather, what is disproved is not the absolute but, much more relevantly, the possibility of an absolute language.

The adoption of the concept of ecology allows Isabelle Stengers to address this problem from a new angle and to step out of the image of equivalence that has organised physics since the onset installing a convergence with ontology.[64] With ecology Stengers proposes a multiplication that celebrates the plurality introduced by the relevance of the materiality of languages, rather than mourn representation. The "specificity of factishes," that is the heterogeneity and locality of their emergence, and the local production of the criteria with which a practice works, means that not all practices function in the same way and that not all factishes are the same.[65] In this light, reciprocal capture is not an arbitrary practice circulating without concepts, but a process that generates its concepts locally; a form of emerging coherence that exists in ecological equilibrium with other practices. Stengers invokes a new orientation of ontology towards the sensual materiality of the present, listening to finitude and becoming attuned with its patterns and their relevance, rather than seeing through matter in the name of a transcendental or totalising absolute. In this new orientation the fact produced by scientific practices shares the same constructive logic that operates in the practices of art. This brings to light a different type of convergence between this new onto-epistemological approach and the modes of operation and the questions of artistic practice that demands an entire reconceptualisation of ontology moving from aesthetics.[66]

Aesthetic as Coming to Presence - Stengers' argument is an attack on Kantian *universality* as the parameter upon which judgment is possible and acts as the foundational dimension of the modern. The universal installs a form of judgment that is intrinsically

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[64] Cf. Stengers, *Cosmopolitics*, Vol.1, 33.

[65] Cf. Ibid., 41.

[66] Steven Shaviro has also attempted to develop a thought without image into an alternative interpretation of aesthetics. However, he has overemphasised the role of the virtual over the openness of speculation and has therefore circled back into a space whose a priori criteria are simply transcendental rather than transcendent. Cf. Steven Shaviro, *Without Criteria: Kant, Whitehead, Deleuze and Aesthetics*, (Cambridge, MA: The MIT Press, 2009).

political, since its first aim –Stengers points out- is the disqualification of potential competitors in the struggle for establishing the unit of measure and the logic that will dictate the organisation of the present.[67] Challenging this universality from the ground of matter, as the sensual that matters, brings aesthetics to the fore alongside political and epistemological issues, presenting them not as the attributes but as the pillars of ontology. What is more, by distancing herself from Kant, Stengers (and in this regard also Barad) does not reject the notion of transcendental noumenon wholesale. Instead the aim is to show how the transcendental horizon hosts a plurality of non-hierarchical modes of organisation.

The demise of the absolute and immediate knowledge through the finitude and openness shown by Prigogine, both allows and demands to question the notion of matter as the object of knowledge. Claiming that one should not speak of an *object of knowledge* but of an *object of sense*, or the factish, would seem the most straightforward solution. Indeed, the factish is the epistemological interpretation of a present emerged from the reciprocal relations that constitute augmented causality; it is irreducible and stands in opposition to the hollowness of the simulacrum. However, at this stage even the notion of factish should be subject to scrutiny, or rather it should be exposed as a rhetorical device that has helped the argument move past the binary distributions of concept-object, which provide the ground for the distinction between true and false claims. Indeed, the factish still belongs to the identity structure that separates facts from fiction. While emergence presents local and heterogeneous dimensions where the distance between the aesthetic level of the surface and the ontological depths is no longer a valid category. It is a distribution that has become meaningless and here gives way to a continuum where practice and factish are idealisations as much as the subject and object at the extremes of the same segment of sense. What is at stake is a rhizomatic dimension of sense, where the self-constrained emergence of the fact reflects non-integrability through a positive prism. Indeed, one should

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[67] Cf. Stengers, "The Science Wars," in *Cosmopolitics*, Vol.1, 1-83.

instead think of a continuity whose fictional abstractions are projected as matter, the empirical fact, the demands it raises, and the relevance these manage to muster; that is, the relational network it can generate. In this shift, the meaning and logic of sense of the present stems from the materiality of its constraints, but this materiality has changed meaning from tangible mass to that which matters, and how and for whom it matters; in physical terms it is both material and immaterial. Diffraction and mattering, associated with the chrono-logical increase of causation and information at contingent level, make the present (the sense of the presence of the present, which is not the same as to say the givenness of the given) a network of particles/matter and immaterial relations in one continuous sense-present.

As with the abdication and withdrawal of physics, or counter-actualisation, concerning demonstrations of impossibility, the claims about reciprocal capture and diffractions are not proposing a new universality any more than Prigogine did theorising irreversibility. Vice versa, these concepts are possible and their questions necessary precisely because chrono-logical irreversibility prohibits the idealisations towards a totalised unity. Likewise, the notion of factish could not have been formulated without the fragile condition in which Stengers found science after Prigogine's reconceptualisation. Equally here diffraction and relevance do not emerge as a paradigm that simply replaces one methodology with another. What these concepts do is precisely the opposite of converging onto a new ultimate. Indeed, they prevent the image of thought, whichever it may be, from completing the totalisation it intended to perform and express all the creative import implicit in demonstrations of impossibility, beginning with Gödel's incompleteness.

Before delving in the renegotiation of the concept of aesthetics, on last clarification is necessary. Isabelle Stengers has shown that the languages of science, like the language of ontology, like all languages in fact, are not transparent and the demands raised in their activity and circulation constrain the information that they are supposed to transmit and represent. Crucially, this is not simply a bias that could be dismissed offhandedly invoking demons or supercomputers, but a truly genetic aspect intrinsic to the mechanics of the

paradigm of representation. Reductionist ontology, blinded by idealisation, has ignored the materiality of its languages and their relevance; has ignored that languages matter.

Yet, Stengers' argument goes further and extends this material sensual opacity of language to the questions raised by the relevance one proposition may have over another and feeds them back into the loop that supports the construction of sense. This brings forth a parallel logic between art practice and scientific practice, as both ontologically genetic, which is not the same as pointing downward towards an ontological common denominator they would both share. As Stengers and Barad have made clear, heterogeneous practices diverge; their constraints are not the same across sciences and do not constrain in the same manner. However, being ontologically creative does not mean fabricating truth arbitrarily. While the notion of practice names a genetic thought and a creative activity, art and science are not the same practice; they both experiment, but the demands of art's constraints lead to an entirely different configuration than those of science. Their parallel repositioning in relation to the questions of the logic of sense is due to ontology having had to let go of its authority.

This is a moment of shifting perspectives and it is important to avoid the risk of confusion. As it was seen regarding Prigogine and Stengers work on dynamics, the reconceptualisation taking place here is not a paradigm shift, but rather a critical interrogation of the notion of paradigms. The disruption of ontological hierarchy presenting art and science as equally genetic practices, does not amount to install a new transversal homogeneity, or to claim that the scientific fact is a subjective fabrication. In fact, there is an inversion at play here, which leads to a turning inside out of ontology. The reversal that undermines the ontological authority stems from the impossibility of integration encountered at the contingent level of presence (aesthetics). Some of the pivotal claims seen in previous chapters, such as the "laws of physics are not the laws of nature" or, which is the same, the fact is constructed and nevertheless it is "referred to as real" and, lastly, "the world materialises differently through different practices" are nothing but the encounter with the

undecidable propositions in Gödel's proof.[68] They express the non-integrability of the system into the specific organisations of sense in the present. They make sense from the specific level of complexity of the present. Sense expands from the pattern of the local and heterogeneous practices; that is, from its dimensions. Undecidable propositions express sense in a manner that cannot be deduced from or reconduced to initial axioms; they make the space in which both they and their sense are valid, beyond the distribution of a space of non-contradictory theorems derived a priori. In fact, they generate local and emerging dimensions for the sense they express, rather than resting on external coordinates that structure the background as a stage. In this light, once representation has yielded its universal claims, science, art, and philosophy are realigned without hierarchy; positioned at the same distance from sense. They express a convergence on the question of mattering while diverging in their practices and answers.

4.4 Aesthetics after Complexity

The thesis' subtitle "aesthetics after complexity" indicates that finitude has nothing to do with the aesthetics of complexity and everything to do with the *complexity of aesthetics*. This is no mere alternative between two parallel interpretations, choosing one topic over another. Indeed, the wager is a radical divergence in thinking ontology. Exploring the aesthetics of complexity would amount to nothing more than perpetuating the structure of a binary ontology that divides sense in concept and object, or object and image; it would continue to relegate aesthetics to the domain of matter and bodies as the surface of Being. Aesthetics, therefore, would remain a category valid for making claims about the contingent phenomenological appearance but submitted to the higher hierarchy of ontology, as the logic of pure Being that it must leave untouched, obediently yielding to it the right to investigate the logic of sense. The complexity of aesthetics, on the other hand, points to the fact that incompleteness implies an irreducible materiality. As Prigogine and Stengers have

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[68] Cf. respectively: Stengers, *Cosmopolitics*, Vol.2, 201; Stengers, *Cosmopolitics*, Vol.1, 19; and Barad, *Meeting the Universe Halfway*, 89.

shown, non-integrability entails an irreducible degree of roughness that makes the present and its logic intrinsically sensual. The chrono-logical distance produced by irreversibility is key for understanding the shift that is taking place here and how this brings aesthetics to the fore as primary. This is no mere emphasis on temporality or becoming, rather it implies passing from a transcendental ontology to a *metastable logic*.

In rejecting sameness as the a priori image of thought, Deleuze exhorts the thinker to "count upon an encounter," rather than on the self-sufficiency of identity, as the reason for thought and the question of sense. This encounter takes place outside the grid of the intelligible recognition of the same and "can only be sensed." However, this is not the object of phenomenology, as sensible experience, which would converge with other faculties onto a "common sense." It is "not a sensible being but the being of the sensible," Deleuze writes, "not the given but that by which the given is given." In fact, it is "imperceptible;" entirely beyond the senses and outside recognition. This, Deleuze specifies, is a "transcendental exercise." However, while this exercise bypasses the authority that a priori concepts claim on the organisation of sense in the present, it also bypasses the material presence of matter, pushing that which matters to something purely ontological (the being of the sensible); something that, as Deleuze claims, is at the transcendental limit of the senses.[69] Therefore, the distinction between aesthetics and ontology is still firmly in place, and so is the hierarchy that sees sensible presence as less relevant than the abstraction of Being. The "*spring and let go*" that Heidegger advocated in the lecture on the principle of identity, if it is really meant to take us beyond the enframing of metaphysics, must jump further than this skip from perceptions to Being bypassing the concepts of intellect, which only mimics the Kantian sublime.[70]

Metastability shows that this encounter takes place with entirely different parameters. In *Order out of Chaos* Prigogine and Stengers have explained that in unstable

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[69] Cf. Gilles Deleuze, *Difference and Repetition*, 176.

[70] Cf. Martin Heidegger, "The Principle of Identity," in *Identity and Difference*, *Identity and Difference*, trans. Joan Stambaugh, (New York, NY: Harper & Row, 1969), 23-41.

states fluctuations may become amplified, leading the system to evolve "towards a new regime that may be *qualitatively* quite different from the stationary state" at equilibrium.[71] This qualitative jump is a crucial but delicate moment. It would be hasty and also inaccurate to identify it with a passage from *quantity* to *quality*, where the sum of empirical instances generates a new concept for the cohesion of such organisations. As for the rhizomatic assemblages, it is impossible to abstract it into the empty dimension of an "overcoding" unity. However, the new emerged present is not the determinate actualisation of a transcendental quality; nor it is a differential of the partitive "some," which for Deleuze and Guattari replaces identity and circulates on the plane of consistency.[72] Instead, this passage marks the emergence of entropic forms of organisation, or *dissipative structures*, which result from an uphill fugue of the system (the non-standard attractors of chaotic behaviour seen in chapter 2). It generates more order and more information at the expense of more energy. To the increase of entropy there corresponds an increase in complexity. Therefore these new forms of organisation can also not be assimilated to epiphenomena, as logically ephemeral events that point downward for objective causes. Indeed, dissipative structures are not devoid of legitimacy or identity, but obtain it by emerging from augmented causation. Precisely because they do not fulfil a concept and maintain their cohesion only through energy dissipation, they remain open and susceptible to change; that is, they are metastable. Therefore, what is encountered is a chrono-logical organisation of organisations, never pure but always material and synthetic.

The openness of metastability also means that the very process of emergence cannot be universalised. Meta-stability is an attribute of the present, not something that surrounds it and houses it. As the history of the system is a mixture of necessity and randomness, where the width of Ljapunov's temporal frames mirrors the pattern of self-constrained chance of Mandelbrot's iterating loops, the ultimate is unreachable and the

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[71] Cf. Prigogine and Stengers, *Order Out of Chaos*, 141.

[72] Cf. Gilles Deleuze and Felix Guattari, "Introduction: The Rhizome," §3, Principle of Multiplicity, in *A Thousand Plateaus*, *Capitalism and Schizophrenia*, trans. Brian Massumi (Minneapolis, MN: University of Minnesota Press, 1987), 8-9.

process only evolves from the present.[73] "There is no longer any universally valid law from which the overall behaviour of the system can be deduced -Prigogine and Stengers write- each emerged system is a separated case."[74] The loss of the foundational parameters of *universality*, *law* and *deduction* upturns ontology. The process can only grow from the *now*, as the middle of rhizomatic logic.[75]

Also the coherence produced from this metastable middle is not integrable any more than it keeps the system at the edge of chaos, as a transcendent or transcendental horizon; it is not a regime of actualisation and counter-actualisation tangent to the plane of a body without organs. Rather, organisation emerges precisely because non-equilibrium induces irreversible processes. Thinking for a moment of Leibniz compossible and incompossible evolutions, one sees that the distance from the equilibrium of the actualised infinity of possibilities installs the irreversible entropy barrier that supports the coherence of the present. Complex systems diverge from the isotropic equivalence of universality along univocal lines. Metastability makes this univocity a chrono-logical distance instead of an ontological continuity in which events are embedded. Laws are universal only at equilibrium, where the state is isotropic and all its points and properties equivalent.[76] Yet, on the threshold of non-equilibrium they diverge becoming highly dependent on the specificity of local processes. The universal equivalence of this present with any other present is broken; the greater the distance from equilibrium, the higher the degree of complexity. The present is finite because its logic is no longer universal and it is positive because it generates the dimensions of its existence. Thus, the present is not the surface of a depth, or the representation or expression of Being, rather it is organised through irreducible genealogies. It *is*, without being in function of something else. Phenomenology coincides with ontology. Yet, it is not immanence that one encounters in complex processes. Emergence is a process of augmented causality and expansion of possibility, which

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[73] Cf. Prigogine and Stengers, *Order Out of Chaos*, 169-170.
[74] Cf. Ibid., 144-145.
[75] Cf. Deleuze and Guattari, "The Rhizome," in *A Thousand Plateaus*, 21-25.
[76] Cf. Prigogine and Stengers, *Order Out of Chaos*, 181.

continuously generates coherence. A continuously emerging ground (generated by resonances, fugues, feedback loops, adjacent possibility and relevance/diffraction) produces the present as a genuine production of new forms of existence. Metastability acts as the condition for coherence outside immanence or representation binaries. In this light, Heidegger's spring demands that thought sheds its last references to identity and embrace the metastable logic of the questions of "how and for whom this matters."

As the present is the finite product of a self-constrained process of emergence, its organisation, epistemological distribution and political tensions, as well as the logic that rules its iterations, are an evolving pattern, which constitutes both its dimensions and its possibilities. As the present cannot be identified as a state defined by coordinates, it is not a point in the evolution of a system whose boundary conditions are known with absolute precision. Instead, what describes it, what names and rules its sense, is the logic of its evolution, which is determined locally by its very organisation, that is, by the self-constrained process of emergence that has lead to this specific *here* and *now*. Thus the present is neither the emptiness of the intersection of pure time and space in "the now" of Hegelian dialectics, nor the infinitesimal instant of Deleuzean ontology both infinitely subdivided and always tangent to the transcendental horizon of difference.[77]

The materiality of incompleteness does not demand the study of the aesthetic of this materiality, but rather that the complexity of its presence (aesthetics) be investigated through a renegotiation of the notion of givenness that does not attempt to transcend the given. *Dimensionality* names this logic as a degree of roughness and intensity of complexity, the patterns of organisation and distribution, the repetitions and the rhythm of iteration that constitute the dimensions of the present as a singularity.

Aesthetics as Matter and Relevance - So far, the thesis has identified aesthetics with the presence of the present, summarising thus the classic ontological partitions between

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[77] Cf. Georg Wilhelm Friedrich Hegel, "Sense-Certainty: or the 'This' and 'Meaning'," in *The Phenomenology of Spirit*, trans. A. V. Miller (Oxford: Oxford University Press, 1977), 58-66; Cf. Deleuze, "Repetition for Itself," in *Difference and Repetition*, 90-163.

surface and depth or object and concept, or the image of a body. Aesthetics has been treated without paying particular attention to the distinction between the two recurring interpretations, which have run parallel to each other since Kant had split the encounter with the object, between the first and the third critique, separating the sensorial perceptions and the pure and disinterested contemplation attributed to the artistic domain.[78] However, the point is not to disentangle their intersecting paths any more than to rejoin them into a unity.

In metastable regimes emergence is a process that makes worlds; it makes presence and in this terms it is aesthetic. However, at the same time, it is also a process that *makes sense*, and in these terms it would amount to more than phenomenological aesthetic presence as it is grasped in binary structures. In fact, the problem lies precisely with keeping apart presence and sense, or better material and immaterial. As it has been discussed, emergence and metastability upturn this binary structure of ontology for a heterogeneous logic of sense (or topology) where the question why is there something rather than noting, which addresses presence, cannot be separated from the question how are things organised thus rather than otherwise, which addresses sense. The very meaning of aesthetics has shifted: for what concerns judgment, after complexity aesthetics must expand beyond the appreciation of the physical object of the senses, to include both the material and immaterial aspects of the present, the mixture of mass and relations, matter and discourses; the necessity and randomness that mix in the processes of emergence. Therefore, unavoidably, it has also become an interested judgment: a matter that matters. Where the absence of a concept for the judgment is precisely the openness and exit where the political/ethical questions can act. That is, pronouncing a judgment of coherence without

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[78] The two paths of aesthetics are not exactly parallel in Kant's critical project. Indeed, "The Transcendental Aesthetic," presented in the *Critique of Pure Reason* addresses the dimensions that contain and structure the object of experience in Newtonian terms, while in the "Analytic of the Beautiful" Aesthetic Judgment contemplates in a pure and disinterested manner the logic at play in the constitution of the object of the senses introduced in the first Critique. Nevertheless, the distinction between aesthetics as disinterested contemplation and aesthetics as sensorial presence has laid the terms of the problem around which art is defined and distinguished from the rest of the world. Cf. Emmanuel Kant, "Transcendental Aesthetic" (second edition), *Critique of Pure Reason*, eds. and trans. Paul Guyer and Allen W. Wood, (Cambridge: Cambridge University Press, 1999), 172-192; and Emmanuel Kant, *Critique of the Power of Judgment*, ed. Paul Guyer, trans. Paul Guyer and Eric Matthews (Cambridge: Cambridge University Press, 2000), 89-127.

concept (as aesthetic judgment is for Kant) from inside the limits of Ljapunov's temporal frame cannot take into account a finality and must turn to relevance as a speculative ground. The encounter is not only about the independent and static object of the senses (sensorial phenomenon), but includes discourses and histories, as much as their consequences and risks. That is, the entire genealogy of the phenomenon encountered, which also includes and traverses the observer/subject. Aesthetics comes to the fore as the question of ontology. Thus, speculation, as a judgment of coherence and relevance free from the a priori, is primarily aesthetic.

For what concerns phenomenological appearance a new grasping of matter arises. As non-integrability forbids idealisation, the present cannot be retraced to the origin, the body cannot be reduced to organs, chemical elements or particles in motion; but also the present cannot be abstracted, counter-actualised that is, towards a transcendental horizon of difference. Appearance, life, phenomena are emerged surfaces, networks expressing degrees of complexity, which is both their logic and their life. Reduction equals destruction. Therefore, the presence of the present, seen as contingent and dispensable in linear ontology, that is inessential, must be reconceptualised as a surface, which is not superficial but it is also not becoming essential as ground or Being. The categories of immanence and transcendence have lost their meaning. The present is not the surface of depths and aesthetics is not the image of ontology. The present *is*; it is complex and exists only in its circulation. Stengers sees ecology as a democratisation of epistemological distributions; it is fundamental to also point out that it can only exist in its active exchanges.

This is why severing the surface from foundations does not produce simulacra; or better, it produces simulacra only within the space-event of foundational ontology and representation, which is precisely what complexity overcomes. Thus, aesthetics names the logic of complexity of the present, the liveliness of the body, the circulation of thought on the basis of the circulation of the questions of relevance and mattering, and not just of perception and matter. The present is a network of sense where material and discursive patterns matter for the present and are therefore material.

In this shift aesthetics articulates the continuum of presence: to the extent to which emergence makes worlds (answering why is there something rather than nothing) aesthetic addresses a *genetic* and *poietic* logic; however, since this making worlds is at the same time making sense (organising how are things thus rather than otherwise), aesthetics expresses also the *creative* and *poetic* logic of emergence. In this light, aesthetics as the science of presence and aesthetics as philosophy of art, that is as the elaboration of the practices of making sense, are one and the same question.

In an evolution shaped by *self-constrained chance*, there can be no return to the ultimate; only the rhythm of iteration or fractal dimension constitutes the logic of coherence of the present.[79] A speculative approach can only be meaningful, that is it can only be different from representational ontology, if it gives full recognition to the importance of this finitude. Large Poincaré systems can be cyclical or open (interrupted by resonances) depending on the measurement scale chosen. This in itself constitutes a radical divergence between repetition and chaos. In chapter 2 it was seen how Mandelbrot's question about fractal subdivision: "How long is the Coast of Britain?" highlights how the unit of measure in a geometry of self-similarity makes the difference between different actualisations; equally Stengers has emphasised that the possibility of measurement is an event. In a regime of self-constrained chance, the pattern of organization and the scale of measurement that defines Ljapunov's window respond with a single answer to the ontological question *why* and the epistemological question *how*. There can be something because there is a specific distribution, which constitutes specific possibilities. This must not be heard as an inversion of the hierarchy between the two questions, on the contrary it is precisely the hierarchy that has vanished and with it the distinction between the two orders of existence. This is a speculation that does not wonder into the purity of radical difference, but is always qualitative. Mandelbrot had called these patterns *roughness*, as opposed to the purity of

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[79] Fractal dimensions are not only geometrical distributions, but rule nearly all kind of iterating processes. Mandelbrot has shown for instance that prices' fluctuations in the stock exchange follow fractal patterns too. Cf. Benoit Mandelbrot and Richard L. Hudson *The (Mis)Behaviour of Markets: A Fractal View of Risk, Ruin and Reward* (London: Profile Books, 2004).

Euclidean forms; a roughness which is very regular, in fact self-similar. This roughness is indeed the product of a qualified difference without which there would be nothing. thus aesthetics, is the presence of the given and also its logic. It names a form of dynamic existence rather than a static presence for the senses. A speculative practice of thought posed in this way is interested in the future for what can be done in it and interested in the past for what of it remains/is in the present.

The shift in the image of matter and science brought by complexity demands that aesthetics be disassociated from the senses and realigned it with a form of presence, which cannot be thought of as reducible, but is an incompressible singularity. Metastability is an open mixture of necessity and randomness, or rather process and openness, which makes the historical evolution of a system neither a linear history nor a process of binary branching. Instead, between the simple and the complex one finds a fractal maze; augmented causality is manifold where organisation is a multiplicity of multiplicities; folds that make matter historical and, at the same time, make history matter, both in the sense of history being material, and of history and its patterns mattering for the next iteration of the system. In the present the matter of the discourse (the syntax) and that which matters in the discourse are both material in as much as they are both relevant. This, rather than leading to a regression to infinity, constitutes an entropic barrier. The importance of the work of Prigogine concentrates precisely on this point. Complexity bars following causal chains into the far past of the first cause or initial conditions, as well as into the far future of total equilibrium. As per Ljapunov's windows, information is gained and lost along the history of the system; augmented causality at the same time increases and loses information. What presents itself as the present, the given, can never be bypassed or abstracted to engage directly with its givenness. The encounter, contrary to Deleuze's expectations, cannot count upon that by which the given is given (the Being of the sensible or eventum tantum). It is instead an intrinsically and radically *finite encounter*, and this is precisely what makes it both possible and relevant. To think otherwise, would imply thinking, that is believing and acting, as if the present did not have legitimacy to exist in itself and that aesthetic be only a

surface; thinking that the present's moods, colours, and tensions, all its dimensions, would be just *attributes*, superficial, inessential and dispensable in favour of a reduction of the present to its ultimate; even when this is an event of becoming different.

This is the real onto-theo-logical risk, which Deleuze had not been able to dispel with the speculative approach (any more than Heidegger did through a relational identity presented as an authentic relation), and which finds a far better answer in the locality and heterogeneity of the processes of emergence. Equally, the fact that matter matters must not be allowed to become a metaphysical interpretation of matter, speculating upon the existence of an absolutely independent object (as the recent New Materialism and the Speculative Realism move instead seem to propose). Rather the opposite: the relevance of matter brings contingency to the fore as a barrier for all arbitrary and illegitimate idealisations.

Between the simple and the complex there are many, incalculable and unpredictable folds. The barrier these raise is not a new universal boundary, but demands *thinking in the presence of matter*. This is what Stengers invokes when she exhorts the scientist and the philosopher to listen to the relevance of the contingency and "think in the presence of the victims."[80] Here, the first victim is the contingent and heterogeneous logic of materials, technologies, and indeed the mathematical language adopted to ask the question. By bringing to light the relevance of matter Barad and Stengers have cast a new light on the problem of finite measurement addressed by Poincaré and the elaboration Prigogine made of it, showing how measurement is a always a question of decisions that engender different forms of actualisation. It is choice that makes matter, which in turn is a matter that matters. What emerges is a radically new and alternative form of materialism; one which instead of taking matter as the ultimate or thinking matter in function of the ultimate, concentrates on the complexity of the surface/present as that which matters and dictates the terms of its appearance and behaviour and the dimension of its givenness.

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[80] Cf. Stengers, "The Cosmopolitical Proposal," in Latour and Weibel eds., *Making Things Public*, 994-1003.

Stengers had explained the event of modern science not as the true representation of nature, but as the advent of an event able to dictate its own reasons.[81] This radical grasping of the emergence of presence must concern not only science, but all events of sense; it expresses a radically material logic or *radical matter.*[82]

The question that is progressively emerging in this new conceptualisation of ontology is not how things come into existence (as if there would be only one logic for the emergence of all events), also not how things become (which equally would point to a totalising move, which would again produce one logic of evolution for all events), rather how things *cohere*, which results from a heterogeneous and local process. Crucially, claiming that this logic is heterogeneous and local does not amount to a new generalisation. The only logic that can be applied is that of relevance, or diffraction.

4.5 Dimensions and Dimensionality

The new conceptualisation of aesthetics as the logic of self-constrained processes demands rethinking the notion of dimensions beyond the limits of the sensible. Ontology has projected dimensions as the conditions of experience (namely time and space); categories for the capture of the world in conformity with a logic of generalisation, which must satisfy the demands of the a priori image of thought and organise sense and the universe in a hierarchical manner, converging with intellectual categories towards a *common sense* (such was the position of aesthetic as the threshold for entering Kant's

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[81] Cf. Stengers, "Science under the Sign of the Event," *The Invention of Modern Science*, 71-88.

[82] The concept of *radical matter* was first developed by Johnny Golding in a series of meditations on new materialities, aesthetics and war. Cf. Johnny Golding, "A Deleuzean 'something': n-1 (or the techne of curved line drawing)," *Issues in Contemporary Culture and Aesthetics*, Vol.2 (2004), 59-66; "Raw / Hide: WWW III, the prequel," in T. Barlow ed., *Positions: The War Issue*, (Durham, NC: Duke University Press, 2005), 263-283; and "The Assassination of Time (or the birth of zeta-Physics)," in Hanjo Beressem and Leyla Haferkamp eds., *Deleuzean Events: Writing | History* (Berlin: Lit Verlag, 2009), 132-145. Radical matter then became one of the central concepts of the PHD Research Methods Seminar (Centre for Fine Art Research, Birmingham School of Art – BCU), led by Professor Golding.

architecture).[83] Dimensionality instead seeks to respond to aesthetics in a regime of complexity, including and articulating the genetic and dynamic logic of radical matter.

Stengers has shown how a practice operates by self-constraints. In the feedback loop of reciprocal capture that produces the factish, constraints become the dimensions of the process, which in turn constrain successive evolutions. Thus a practice expresses sense as a fractal dimensionality rather than as representation defined by coordinates. It is worth returning for a moment to Poincaré's impossibility of absolute measurement, to show how in this process finitude generates dimensions and in turn dimensions become possibilities. The limits that Poincaré' individuates for the infinite precision of measurement reflect the *imperfection* of created monads described by Leibniz. This impossibility demands an *approximation* that intrinsically shapes the present. The degree of precision corresponds to the degree of reality actualised. Thus determination generates physical historical existence. That is, determination, the reason why the world is thus rather than otherwise, is the reason why the world is at all. Finitude makes presence; it is positive and genetic. Here the constraints of the approximation become the dimensions of the universe of sense. That is, all events and evolution shift from referring to a priori and external coordinates to developing upon the history of the self-constrained process, which both defines the boundaries of the present and dictates the possible in a heterogeneous and local manner. In the feedback loop of reciprocal capture the practice produces dimensionality. What is crucial in passing from Leibniz to Poincaré is that this is no longer a metaphysical problem; in the light of the work of Stengers and Prigogine, it is revealed instead as a matter of *decision*. The political aspect of the practice and the factish in the regime of reciprocal capture concerns precisely the relevance of the approximation chosen for making sense of the present. That is, the problem of approximation is political because creativity is intrinsic

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[83] This is the critique that Deleuze moves to a conceptualisation of dimensions in function of the a priori image of thought, which for him is also at the root of the split in the image of aesthetics between the domain of the sensible and the disinterested contemplation of the process of perception. Cf. Deleuze, *Difference and Repetition*, 81-82.

to any engagement with the question of sense and with the definition of the dimensions that organise it, which lead to radically different constructions of the universe.

The impossibility of absolute measurement or communication leads to approximation. This approximation is a degree of roughness. The pattern of this roughness determines the present in the sense that it dictates its dimensions; by defining its limits it generates its possibilities. On the open front of self-constrained chance, dimensions and possibilities are one and the same pattern, which constitutes a set of dimensions or dimensionality. The degree of *roughness* produced by approximation marks at the same time the degrees of *freedom* of the system. Roughness emphasises what is actual in the determined pattern of the present; freedom expresses the possibility that the open threshold of this determination allows. Dimensions as roughness, and possibilities as freedom coincide in the pattern of the present. What is more, in this pattern of dimensionality, sense does not *have* dimensions rather it *is* dimensionality. This is a fundamental distinction: dimensionality is not providing dimension as the external coordinates of the event of sense. Rather, the finite pattern of the factish is the present and how it matters.

However, precisely because of the very impossibility of immediate and absolute communication, these possibilities or determinations of the present cannot be projected towards an ontological limit; idealised that is. Non-integrability bars it. As was explained in chapter 3, finitude can no longer be thought of as a differential from metaphysical continuity. Therefore, the present cannot be thought as a threshold that separates order from the disorder, as the metaphor of the edge of chaos would imply. This leads to a radical reconfiguration of ontology. While the finitude of the present makes it intrinsically material, this does not give materiality any privileged position with respect to an idea or concept. On the contrary, the emerging coherence of complexity does not respond to a dualism that sees a materiality paired with or opposed to concepts. Indeed, concepts and matter find themselves on the same side of the divide. Or better, the divide and the extremes have become meaningless categories. Thus dimensionality replaces and includes the notion of dimensions. It names the local and heterogeneous networks and patterns that organise the

present. Moreover, the degree of roughness that determines the present is not universal but plural and open. Different moments may have different determinations with varying configurations and numbers of dimensions. Thus dimensionality refers to multiple definitions. It is the process-specific definition of the regime of sense installed by a given practice; it describes a fully developed and active environment.

One is a Degree of Roughness - The initial degree of roughness is not something one encounters; it is *something one is*. I, the present, a concept are degrees of roughness. A degree of roughness is not a partitive *some*, rather a positive finitude for which no whole can exist, neither transcendent nor transcendental. Roughness is a continuous and yet finite segment; a presence for which the passage to the limit cannot be ontologised. This shifts from thinking of ontology as a segment stretching between zero and one, where zero is the infinity of pure possibility and one total actualisation, to thinking that one is presence (a degree of roughness or complexity), while zero is silence. Zero is not the virtual and one is not the actual. This is the sense of univocity. The metastability of the present replaces the transcendental unity on the ontological horizon leaving the present open.

Here the passage from actual to actual of Kauffman's adjacent possibility and Stengers's reciprocal capture merge with Karen Barad's notion of diffraction, as contingent and engaged patterns of difference that make a difference in the present. Indeed, as was seen, diffraction is not difference. While this concept responds to the same demand of an alternative to the ontology constructed upon a priori sameness, it does not function as an absolute differential. Deleuze had distinguished between contingent differences among things (differen*c*iation) and radical difference, as the pure ontological difference that passes from nothing to something raising determination from the infinity of the pure possibility (differen*t*iation).[84] Barad instead develops a horizontal differential between existing degrees of roughness, where historical configurations differentiate themselves from other

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[84] Cf. Deleuze, *Difference and Repetition*, 256-274.

configurations at contingent level. Diffraction points to the differences that may emerge, rather than the background from which the existing determination has emerged.

To be sure, the question *what is it that makes a difference?* can only be answered with *difference*, radical difference. However, difference is always-already complex. Yet, not in the sense of the condition of a lost immediate communication with the absolute, but, as was seen, in the sense that without determination there is no existence. In this light, it also becomes evident how languages (whichever they may be, mathematics, medium, technology) rather than being inevitably meta-languages are in fact degrees of roughness, genetic rather than representational, depending only on how the materiality of their syntax may matter.

Pausing for a moment to think of Lucretius' *clinamen* as the inspiration for radical difference, it is also worth pointing out that while the clinamen expresses the minimum difference necessary to make a difference, thus marking the passage from the isotropic depth of infinite possibility to the determined and finite configuration of the present, Lucretius also emphasises the fundamental relevance of the chronological process that beings need to follow in order to become what they are (that is, their genealogy).[85] Nothing springs into existence from nothingness as an already completed being. While sufficient reason is confined to chance, for Lucretius the progressive augmented causation of complexity is already at play marking sense with temporal determinations.[86]

Segments, Loops and Continua - In the loop of reciprocal capture that constitutes the practice, the observer, the measurement, and the ensuing result are part of one and the same segment. That is, they form an indissoluble *continuum*; a patterned dimension of sense, to be understood both as the "active matter" that Prigogine and Stengers brought to light in the complex dialogue with nature and as the generative dimensions of Mandelbrot's

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[85] For the interpretation of the *clinamen* as mathematical difference Cf. Michel Serres, "Protocol," in *The Birth of Physics*, ed. David Webb, trans. Jack Hawkes (Manchester: Clinamen Press, 2000), 3-8.

[86] In fact, for Lucretius the direct passage from nothing to something without process would be absurd because it would not structure repetition, but would leave evolution open to a total arbitrariness producing monsters. Cf. Titus Lucretius Carus, §160-210, *De Rerum Natura*, ed. and trans. Armando Fellin (Novara: UTET, 2013), 79-81.

fractal geometry.[87] Such loops are indeed *series*, as Deleuze articulates the *logic of sense*, yet do not express virtual patterns.[88] Their patterned segment is never referring to a pure image; practice is a self-constrained process whose opening onto the horizon of chance is also constrained. The actualisations engendered by diffraction are not ontological differentials, but always and only contingent.

The iteration of fractal dimensions is key for understanding the regime of dimensionality. A fractal form of evolution, acting in feedback loop with the matter it organises, thereby implementing the history of the loops, cannot be abstracted from its process. Equally, the self-constrained dimensions of dimensionality are local and heterogeneous properties of matter that cannot be universalised. Fractal dimensionality is a *patterning* of the present segment of existence.

What is more, fractal dimensions exceed geometry; they rule more than just extension. Self-similarity is an iterating segment that names patterns of behaviour, rhythms, frequencies of repetition and distribution, or intensity of flows.[89] With fractal dimensions the domain of aesthetics, as the emergence and circulation of sense in the present, finds a new rigorous logic, which nevertheless is neither universal nor related only to the categories of perception. Dimensionality defines an object's shape as much as a process' behaviour and expresses the roughness or complexity of the system. Indeed, fractal dimensions are not static and external coordinates, but strings of information for multiplication and subdivision; they are dynamic dimensions that rule organisations, repetitions and evolutions. Stengers had pointed out that the very possibility of measurement is an event. However, the event of measuring is not inert approximation, but reveals the intrinsic creativity of reciprocal capturing in installing the truth of the relative. Indeed, the possibility of measurement marks

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[87] Cf. Prigogine and Stengers, *Order out of Chaos*, 286-290. Cf. also Benoit Mandelbrot, "Dimensions, Symmetry, Divergence," in *The Fractal Geometry of Nature*, (New York, NY: Freeman, 1983), 14-19.

[88] Cf. Gilles Deleuze, *The Logic of Sense*, ed. Constantin V. Boundas, trans. Charles Lester and Mark Stivale (London: Continuum, 2004).

[89] For the relevance of fractals beyond geometrical shapes, beside the work on price fluctuations by Mandelbrot and Hudson mentioned above, Cf. also James Gleick, *Chaos, Making a New Science,* (London: Vintage, 1998); and John Gribbin, *Deep Simplicity: Chaos, Complexity and the Emergence of Life* (London: Penguin, 2004).

an *enframing*. It installs a pattern of order and an economy. In this sense, dimensions are inseparable from the event, they do not lay out possibilities to be fulfilled, or geographies to be explored or conquered. In this light, a fractal dimension or dimensionality is *genealogical*; both in the sense that it is *genetic* as it rules the shape of matter and the rhythm of its behaviour, and that it cannot be rescinded from the *history* that has generated it.

In the feedback loop of self-constraints, the emerging factish acts as a segment, a pattern of sense independent of any ontological background. As the set of relations installed by the factish, this segment is not the portion of a whole, nor does it join existing end points. Indeed, while the segments circulating in dimensionality are continua, they should not be thought of as stretching somewhere on a line between zero and one as differentials. They do not join poles sitting at their extremes, such as concept and object. In fact, they are not anchored in extremes at all, but project them as fictions that belong to the very distribution of sense installed by the reciprocal capture of the practice. The roughness of determination contains such fictional extremes (zero as infinite possibility and one as total actualisation) as its internal articulation. These fictions, or internal dimensions, are the pattern of the factish; they function as currency internal and specific to the emerged organisation. In this light, the patterned segment is neither a differential from a transcendent or transcendental infinity, nor a relation established between existing points. Rather, this pattern is a curvature of existence that shapes its behaviour; it does not mark a cut at a discrete point setting the separation from a beyond. In other words, dimensionality includes the binary distribution of sense in concept and object as the articulation of one segment that organises sense, rather than conceiving it as an external and ultimate coordinate. Concept and object constitute a continuum, while at the same time this structure cannot be seen or accepted as the universal coordinates that encompass all of existence and sense. Rather it can only be grasped as circulating as a unit or segment of organisation that participates to the ecology of sense. Therefore, the encounter with the given must include "that by which the given is given," or Being, as itself a point on the segment of ontological dimensionality. The

ontological binary distribution is not the ultimate horizon of sense, but a pattern where one encounters the world organised thus.[90]

In this light, thinking of dimensions as emerged continua permits moving from a spatialised concept of ontology, where dimensions act as a scenography, and change these coordinates into players shaping the event. Articulations such as subject and object cannot be bypassed or discarded. Yet, this is not because they are absolute, rather because they belong to the contingent roughness of the present. They are the roughness or grit that keeps existence existing and prevent it from sliding off into the complete smoothness of the infinity of the metaphysical possible. They are the determinations that make something stick, stay, repeat, return and become the relevant matter of the present. In fact, such determinations make the present; they are the present. The image of thought that so much preoccupied Deleuze belongs to thought, rather than thought being subjugated by this image. *An image of thought* is in fact *an object of thought*. As such, this object can be used, dismissed, experimented with and modified at will. It is the matter and material of thought.

4.6 Dimensionality

Dimensionality, Reciprocal Capture and Practice - The new grasping of aesthetics as dimensionality does not reintroduce a world *for us*. Reciprocal capture and the factish exist in the emerging environment that the reciprocity installs as a continuity, thus bringing aesthetics to the fore as primary. The *in itself* and the *for us* are two extremes of the same segment of sense. However, reciprocal capture indicates that such a segment does not have to repeat a binary logic, but can be itself multiple: networks and patterns articulated in

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[90] The interpretation of Bergson's virtual that Ó Maoilearca had suggested, as seen in Chapter 3, is again very close here: "duration or *élan* are never pure;" the distortion operated by the "as if" (refraction) produces perspectival images that are ideal extremes, limits or –indeed- virtuals. The virtual is the liminal point that such distortions produce and project. The actual is the interval between these extremes and enjoys "stronger reality." However, Ó Maoilearca points out, Bergson still produces "a system of dualization;" a process or "movement towards and away from 'illusion,' with pure illusion and pure truth being only virtual." With dimensionality instead the thesis proposes to take these entire segments as matter: while, refraction *distorts* reality, the patterns of dimensionality *are* reality. Cf. Ó Maoilearca, "Forget the virtual: Bergson, actualism, and refraction of reality," *Continental Philosophy Review*: 469-493.

multiple vectors, interrelations and players. Dimensionality names this plural logic. It names, that is, a metastable equilibrium of multiple and intersecting segments, which is the terrain of an *aesthetic engagement* rather than the frame of an *aesthetic experience*. In its light, it is possible to rethink art moving from the *practice* rather than the *medium*, in such a way that the material of the practice and what matters for art are one and the same thing.

What is particularly interesting about the notion of reciprocal capture introduced by Isabelle Stengers is that it reinterprets Heidegger's enframing not only as a reciprocity, which undoes the hierarchy of an active and all colonising rationality opposed to a passive sensible and sensual material world captured and kept in proximity or, as Heidegger calls it, "standing reserve."[91] Rather, and most importantly, Stengers turns away from the hope or need to find an exit from such capture, as a path towards a freer and more authentic relation between beings and Being. In other words, Stengers goes further than simply accepting that the real, the thing in itself, is an unreachable groundless ground, to show instead that enframing is a positive concept. This must not be grasped as a compromise, or as the limited perfection of the best possible world produced by a strict non-contradiction reading of Leibniz's selections. Rather, the relation installed by reciprocal capture is positive because it expresses specific determinations and possibilities in the world one engages with. It expresses a world of sense that does not allow conceiving of a beyond. Outside reciprocal capture one does not find the authentic or the absolute, or pure chaotic difference. There is no smooth space before or outside striated configurations.[92] Beyond reciprocal capture there is nothing. The universe of sense bends around the finite pattern engendered by the feedback loop in which those who participate to the practice (observer and matter) emerge endowed with sense in one cohesive continuum. Dimensionality names this logic of cohesion. What is crucial is that following Stengers' notion of ecology of practices, reciprocal capture does not impose a new unique ontological solution for the

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[91] Cf. Heidegger "The Question Concerning Technology," in *The Question Concerning Technology and Other Essays*, 3-35.

[92] The smooth space as the metaphysical plane on which organised territories are striations. Cf. Deleuze and Guattari, "1440: The Smooth and the Striated," in *A thousand Plateaus*, 474-500.

event of sense, but is open and plural. Dimensionality, as this fluid plurality of modes of capture, presents multiple and heterogeneous dimensions.

In this light, the pattern generated by the constraints of the practice constitutes a dimension for both thought and the practice. Dimensions must no longer be grasped as the conditions of possible experience setting the a priori categories that act as coordinates for the space of thought and the universe of sense; rather they are continua that install the factish as an environment both discursive and material. In other words, as the constraints engage and shape the reciprocal capture that makes a practice meaningful, they also act as the dimensions of the sense installed within the practice; they lay out the boundaries of expectations and impossibilities as well as the parameters or the development of proofs, facts, and truth. Therefore, dimensions can no longer be thought of as external and disembodied references for extension or as the frame of the a priori receptacle of all events. The distinction between material and immaterial loses relevance as a general category. In fact, the very binary distribution of matter and discourse is one of the patterns or degrees of roughness that shape the present and thought at the same time.

The logic of radical matter is the expression of this heterogeneous and local dimensionality. The thesis has shown how non-integrability requires that aesthetics must be disassociated from the domain of the sensible and addressed instead as the logic of coherence of a finite present. Dimensionality names the irreducible patterns of this coherence, where the concepts for engaging with the world are neither external nor larger than the event of sense, but are internal and belong to it; thus bringing dimensions and possibility to coincide.

What has kept thought at bay, captured by the structure of linear ontology, is not just an a priori image of sameness that spatialises being and opposes sense to chaos, but also one that keeps matter and the immaterial discourse (or object and concept) rigorously apart, directing thought to think sense and the world as composed of static elements only subsequently entering a relationship. Without undoing this last bastion of binary enframing it is impossible to think the emergence of sense outside the authority of the concept. Equally,

thinking and engaging with the practices of art would be achievable only by reducing them to an exercise of representation that produces physical objects for contemplation. In contrast with this, the reconceptualisation of aesthetics that follows non-integrability imposes that ontology turns away from such a static exhibition of primary components, which only allows for objects and their images, opening thought towards a plurality of articulations instead. This is not a simple shift from being to becoming as the fundamental logic of sense, but a plurality of modes and patterns along which possibilities emerge and change may happen, non-reducible to one essential logic any more than unifiable into a transcendental continuity.

Beyond the impossibility of retracing initial conditions or reaching the ground, the most far-reaching consequence of non-integrability is that it imposes that only the complexity of the present can provide an ontological reference for both reason and matter, or sense and its possible evolutions. It was seen in chapter 3 how complexity develops an alternative formulation of the rhizomatic logic, requiring that the irreducible chrono-logical distance between the present and the ultimate be taken into account as an essential dimension. In this light, the rhizomatic principle of *multiplicity* shows all its potential as a network whose equilibrium evolves according to the evolution of its internal configurations and assemblages.[93] However, this can happen only on condition that this multiplicity is not made into a "substantive," as Deleuze and Guattari instead would want. Indeed, it is paramount that the multiple remains such: open, plural, and metastable.

The rhizome was introduced as an alternative to the ontological structure of concept-object and representation. Instead, in a regime of dimensionality these distributions belong to the rhizomatic logic as one of its possible lines of development. They are one of the patterns internal to its regime of evolution; that is, its dimensions. They are part of the contingent interrelations and differentiations of the ecological equilibrium taking place inside the rhizome, rather than the ontological differential between the rhizome and the horizon.

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[93] Cf. Deleuze and Guattari, "The Rhizome," in *A thousand Plateaus*, 3-25. See in particular §3, "Principle of Multiplicity."

Indeed, for Deleuze and Guattari a multiplicity cannot be "overcoded" (given a totalising name or identity), but must remain a relation of relations, which cannot change without affecting the nature of the multiplicity. The overall identity is not fixed. In this sense the rhizome is metastable. However, the prohibition of overcoding, or totalising, must be re-stated from the ephemeral intensity of the present. Indeed, *totalising* is nothing but another internal dimension of the metastable equilibrium of the present. It is not to be rejected, but adopted as an *object of thought* rather than it's a priori *image*. As long as the rhizome is pictured as tangent to a plane of consistency, which both provides a "grid" or matrix for it but remains external to it, "outside" the multiple configurations of multiplicity, the possibility of a concept or a subject must be banned to make sure that the risk of a colonisation of the relative openness of the rhizome is avoided. In other words, the "impossibility of supplementary dimensions" must remain an impossibility, without passing over to a transcendental ontological continuity. The system must remain open and metastable.

In fact, non-integrability shows how this impossibility means that there can be no "asubjective" or undetermined dimensions in a metastable regime. On the contrary, dimensions are always contingent and actualised relations, never elevated to the ultimate; they are historical distributions that matter, determined, finite and yet open; the product of diffractions and producing diffractions. Dimensions are not hinging on a third external or transcendental position (solid ground or difference), rather they refer to their past history and their future relevance. Only in this sense can the rhizome be said to expand and grow from the "middle." Indeed, non-integrability imposes to turn the process of actualisation around: The singularity, *now* or *myself*, does not emerge by diverging from a virtual or transcendental possible on the horizon, as the actualisation of N-1 dimensions; but rather, it rises from the metastable coherence of the system. Therefore, "N" must be grasped non-ontologically as the maximum possible degree complexity and information reached in the present; that is the history of the universe. This is a history of actualisations, or (given the limits imposed by Ljapunov's windows), a *genealogy*. Thus, dimensionality names this

material-discursive configuration as a historical rhizome without plane of immanence; the present is the equilibrium of a plurality of self-constrained practices that act as *continua*.

Dimensions, Phenomena, and the Continuum - In complex regimes, dimensions exceed the conditions of sensible experience, but this excess is not geared towards an encounter with the being of the sensible, as invoked by Deleuze. Rather, it is oriented towards opening a plurality of possible patterns for organising sense beyond the binary limits of extended matter opposed to the immateriality of discourse. Stengers had reconceptualised scientific practice as reciprocal capture that produces truth and installs the parameters of judgment in simultaneity, likewise Karen Barad describes the scientific apparatus as a "boundary drawing practice".[94] Both concepts converge onto an intrinsic genetic aspect of the practice that problematises the encounter with the being of the sensible to the point of challenging the univocity of the Being revealing itself in it. Barad claims that "the primary ontological units are not 'things' but phenomena" and to follow, that "the primary semantic units are not 'words' but material-discursive practices through which (ontic-semantic) boundaries are constituted."[95] The irreducible pattern of Stengers' factish is one of such units, both at ontological and semantic level.

Deleuze has positioned art at the point where the being of the sensible reveals itself in an encounter where perception is free from the categories of generalisation.[96] Thus he interprets art as a material practice whose experimentations have only the function of bringing the imperceptibility of Being to reveal itself through it; thereby, once again confining art to the senses and diminishing the relevance of its sensuality.[97] On the other hand, by moving from Stengers' practice to Barad's phenomenon, the univocity at the horizon of all contingent and historical events breaks open and explodes into a non-hierarchical

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[94] Cf. Barad, *Meeting the Universe Halfway*, 140.

[95] Cf. Ibid., 139-141.

[96] Cf. Deleuze, *Difference and Repetition*, 81-82.

[97] Deleuze interpretation of art directly echoes Heidegger's "The Origin of the Work of Art," but is also not very far from a Hegelian interpretation that positions art in function of the synthesis of a concrete Being or Concept. Cf. Martin Heidegger, "The Origin of the Work of Art," in *Off The Beaten Track*, eds. and trans. Julian Young and Kenneth Haynes (Cambridge: Cambridge University Press, 2002), 1-56; and Georg Wilhelm Friedrich Hegel, *Introductory Lectures on Aesthetics*, ed. Michael Inwood, trans. Bernard Bosanquet (London: Penguin, 1993).

multiplicity or ecology. Therefore the experimentation that Deleuze had attributed to art takes place among different practices and phenomena, rather than on the threshold between the sensible practice and transcendental Being. This introduces heterogeneity where, as Barad puts it, "one part of the world makes itself differentially intelligible to another part of the world."[98] This direct engagement of parts to parts, rather than part to ultimate, is of particular importance. Here Barad's ontologically unitary phenomenon and the distributing apparatus converge with the notion of practice as reciprocal capture that Stengers had individuated in science and in any decision that makes sense. In this light, the practice is a material-discursive continuum, where not only can the object not be disentangled from the subject, but also the phenomenon cannot be thought as taking place inside a priori dimensions and generates instead the dimensionality of its own happening. In fact, Barad's phenomenon and apparatus as primary ontological units and Stengers practice as reciprocal capture help to articulate an exit from the univocal ontology that constantly returns aesthetics, the sensible and the sensual to a subordinate role in function of reaching Being. At stake there is a horizontal multiplication: practices that draw boundaries by developing undissolvable reciprocities, which articulate sense rather than representing it, break open ontological univocity and present it with horizontal and multiple encounters between equals, where relations are reciprocal diffractions.

Radical Matter as Dimensionality - Dimensionality rearticulates ontology along two parallel and reciprocally supporting vectors. On the one hand, an ontology constructed on dimensionality emphasises the genetic and creative role of constraints. On the other, dimensionality as a plurality of heterogeneous and local iterating patterns does not answer questions of identity or reduction, which imply idealisation, but expresses the forward-looking demands of relevance and mattering raised by Barad and Stengers.

Dimensionality is radically material. However, radical matter is neither rooted nor rooting. On the contrary, not only is it not rootless, which as a negative definition would

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[98] Cf. Barad, Meeting the Universe Halfway, 140.

reduce it to a simulacrum, but it is a singularity. At the same time, this does not imply immanence. In fact, the singularity of the radical is entirely contingent and open. Radical matter is *asymmetric*, marked by the metastability of dissipative structures. That is, asymmetry is not just the interruption of the economy of representation, as Deleuze poses difference;[99] it is instead the product of augmented causation as the irreversibility and the breaking of equivalence between practices and ontology. Radical is the emerged surface cohering without a priori concept. It is oriented forward, always a result, contingent and yet with consequences; it is the logic of sense, rather than the ontology of Being. Likewise, *material* is not simply mass; it is not limited to tangible extension, the body, the senses and the domain of perception. Material is all that matters, that which can have an effect, is relevant and has consequences; all that can be implemented and generate diffraction. Habits, desires, expectations, histories, beliefs, fashions, nuances, prices, atmospheres, but also codes, algorithms, software, images, are as material as the flesh of the organized body; the machinery of the mode of production, or the technology and the hardware embedded in the world. Material is the thought without which there would be no sense.

In this light, the factish is not just the truth of the relative produced within the scientific discourse. All the segments that participate to the logic of sense are to be treated as emerged factishes; acting on the basis of their ability to become relevant by dictating their own reasons - as Stengers has interpreted the initial event of science. The ontological paradigm of representation is no less a factish than the neutrino; a dimension that generates possibilities upon which conjectures, refutations as well as artistic experimentation can develop. Such segments function as interference elements to be plugged into the demand that the world, other individuals, society, or technology poses to us as something that needs addressing. Dimensionality expresses the modes and the patterns of thought and practice that shape the world in any given way. Thinking in terms of linear causality is a dimension, and so is probability or augmented causality. Faith in the

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[99] Cf. Deleuze, "Asymmetrical Synthesis of the Sensible," in *Difference and Repetition*, 280-329.

possibility of objective knowledge is a dimension of thought. A paradigm that prescribes how to treat such dimensions is also a dimension of thought. A dimension of thought is that art must be an object identifiable through the senses, or defined in negative relation to this identification. Capitalism is a dimension, desire, speed of connectivity in the network are all instances of dimensionality. Dimensionality is the inseparability of presence and its forms and iterations.

Dimensionality and Genealogies - The concept of dimensionality offers an alternative to the image of a relation presented either as an always-already established relationship between extremes, which can be idealised as existing in themselves, or as circulating in a virtual form. Both these interpretations still accept the structure of the problem as it was framed by metaphysics and identity. The first by abstracting the identity of the extremes of the segment, the second by pushing contingent relations to the horizon, as the pure ontological existence from which finite determinations would diverge. The question instead should address how to think a continuity that does not separate the players from the sense they are embedded in and which they express at the same time. The path that the thesis proposes is that by thinking this problem through the prism of complexity, both the always-already and the relation can only be encountered and thought in contingent historical terms. Indeed, as non-integrability bars the idealisation of the end points of a segment as much as the abstraction of the relation, it imposes a limit that at the same time offers a solution by presenting itself as a *genealogy*. However, in this case genealogies do not return to the linear unravelling of identity ruled by non-contradiction, but articulate a history of shifts and changes.

Non-integrability has shown that the chrono-logical process cannot be excluded and the temporal aspect constitutes a fundamental constraint for the logic of any form of presence. The fractal recursive interpolations in the loops of self-constrained processes make the evolution of the system intrinsically contingent and material. As was seen, the present is not a point on a line between past and future, but rather a window framed by Ljapunov's approximation limits, which effectively expresses the *middle* from which the

rhizome can expand. As the present emerges retroactively it expresses a coherence, whose pattern or roughness constitutes an image of the system. However, the progressive loss of information marked by Ljapunov's frames forbids a direct passage from the present to this image, allowing only an engagement with the complex depth of history. Therefore, the system's only reference is the evolution of its process. This metastability gives a certain thickness and opacity to the virtual image of the present, making it historical rather than transcendental.

In this light, it becomes evident that Stengers' factish or the entangled phenomenon that Karen Barad has reinterpreted as a primary ontological unit are not only a basic degree of roughness that cannot be further reduced. The self-constrained loop of process and results makes them also radically historical. The continuum of sense has a history made of questions and processes, increases of complexity and organisation, and the progressive fading of information on the thresholds of Ljapunov's windows.

Moreover, the relevance of the specificity of such processes shows that genetic logic is not an exclusive property of speculative concepts or virtual images, but belongs to the present. Indeed, a segment of sense or phenomenon is not closed; an image is not flat; a concept is not a point without dimensions. Instead they stretch along the hinges that mark their evolution. Foucault had invoked these same genealogies in the analysis of history, pointing out that documents are not "monuments" to be revered and left unquestioned but nodes in a network that cannot be ignored.[100] Likewise, concepts and phenomena are segments that carry the process that has brought them to be what they are in the present as intrinsic to their image. Thus, the segment of sense (or continuum) is not static and linear, but a pattern of multiple diffractions. Or, diffraction takes these genealogies as its

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[100] Cf. Michel Foucault, "Introduction" and "The Discursive Regularities," in *The Archaeology of Knowledge*, trans. Tavistok Publications (London: Routledge, 2004), 3-22 and 23-88. Genealogy cannot be discussed without an echo of Nietzsche. While it is outside the scope of this thesis, it is worth pointing out that the notion of metastability could be read through the prism of the eternal return guaranteeing the openness and fluidity that Nietzsche sought in the organisation of sense. Cf. Friedrich Nietzsche, *The Gay Science*, ed. and trans. Walter Kaufmann (New York, NY: Vintage, 1974); Cf. also Friedrich Nietzsche, "Hecce Homo; How One Becomes What One Is," in *The Antichrist; A Curse on Christianity*, trans. Thomas Wayne (New York, NY: Algora Publishing, 2004), 11-98.

material, thereby generating further possibilities and keeping history open. This forward-oriented regime makes diffraction the legitimate heir, albeit a non-linear one, of the logic of compossibility of Leibniz and of Kauffman's adjacent possibility, which sanction coherence on the basis of their consequences rather than through a priori justifications.

In the light of this, genealogies can be seen as constituting an alternative that secularises the virtual, showing how the image of the present belongs in fact to it as one of its vectors, rather than defining the limit of the present's ontological horizon. By undoing the authority of identity with an intrinsic metastability, genealogies replace virtual images for contingent histories, which remain the only reference allowed by non-integrability. Dimensionality is this genealogical movement that cannot be reduced to a point and remains open, constituting the space in which possibility operates. Matter, that which matters, is nothing other than the genealogies that constitute it; the organization from which the temporal evolution cannot be excluded. What is more, as will be seen in the conclusion, the materiality of genealogies constitutes the material of art practices: the history of a medium, of a concept, or a practice are the matter and what matters for artistic experimentation.

Dimensionality and Objects of Thought: Meillassoux and the Universe of Sense - In the light of the concept of dimensionality it is possible to indicate a path for answering Meillassoux's claims regarding the reintroduction of the absolute. Meillassoux accuses of solipsism all ontological interpretations that concentrate on relations rather than accepting the dogma of the absolute. However, conceiving the world *in itself*, without us, it is not the same as thinking of an independent object *outside us*, which we the subject would reach immediately thanks to some privileged form of representation (mathematics). On the contrary, the world in itself belongs to us in the most intimate way. *Thinking of the world in itself* is a dimension of our world, one of the many curvatures of thought; a degree of roughness or dimension that constitutes the universe of sense.

Rather than precipitating us into solipsism, this shows a conflation of two terms in Meillassoux's argument regarding the in itself that leads to considerable confusion. By

attempting to install an *ancestral* object that would have existed before any human measurement could have taken place (the object in itself), Meillassoux overlooks the problems implicit in the relevance of the scientific apparatus, putting the science he would like to work in favour of his argument in a very difficult position. Indeed, presenting the in itself as an object before and outside us, is not the same as thinking of an a priori element of thought that acts as a condition for thought itself, and is logically rather than chronologically a priori. The proof of the ancestral object seems to confuse the ground with the pavement.

Indeed, Meillassoux is "blinded" by the very science he hopes would provide a proof for his demonstration.[101] In fact, Meillassoux calls upon science to provide a proof for the existence of the absolute. However, he expects this proof of the existence of the *in itself* to operate entirely beyond the impact that the syntax of science may have on its subject, therefore denying that such an object may also exist *for us*. In so doing, Meillassoux not only makes science transparent but also irrelevant, effectively depriving it of the very authority that would have supported his claims. Meillassoux's interpretation of the existence of the neutrino, both discovered and created in the laboratory experiment as something that had always existed, as a proof of an object in itself is akin to withdrawing the famous ladder when bowing to the impossibility to explain how language gives us a picture of the world it represents.[102] Pretending to prove the absolute in itself through language, mathematic or otherwise, amounts to denying not only the relevance but also the role language had in leading us to the absolute. *Thinking of the world in itself* is a dimension of our world.

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[101] Cf. Matthijs Kouw and Sjoerd Van Tuinen, "Blinded by Science," in Sarah De Sanctis and Anna Longo eds., *Breaking The Spell: Contemporary Realism Under Discussion* (Milano, Mimesis International, 2015), 115-130.
[102] For the paradoxical existence of the neutrino Cf. Stengers, "The Neutrino's Paradoxical Mode of Existence," in *Cosmopolitics*, Vol.1, 14-27. The image of withdrawing the ladder after having climbed inside language was used by Wittgenstein to depict the impasse he had reached at the end of the *Tractatus*. Cf. Ludwig Wittgenstein. *Tractatus Logico-Philosophicus*, trans. D. F. Pears and B. F. McGuinness (London: Routledge, 1974).

5 Conclusion

5.1 Art is a Practice of Diffraction

The thesis has sought a way to articulate analytically the methodologies through which contemporary art operates and makes sense. As was seen in the introduction, the poetic and sensual logics of contemporary practices cannot be addressed from the platform of existing aesthetics. Indeed, the binary ontological separation of matter and immaterial concepts on which aesthetics has been constructed keeps returning as the unquestioned structure for the relationship between thought and practice. This perpetuates the identification of art with perception and matter on the basis of the medium; or condemns it to an ana-aesthetic form of expression more similar to visual communication, effectively drifting towards the resurrection of the distinction of form and content.[1] It seemed therefore necessary to develop conceptual tools able to engage with art practices that operate outside traditional disciplines and medium-based definitions, and which, at the same time, retain the poetic and sensual modes of making, feeling and being that make art *art*. The problem is therefore not limited to aesthetics, but reaches the core of ontology.

To address this question the thesis has turned to the onto-epistemological shift brought about by the theory of complexity. Indeed, the open and heterogeneous logic of emergence at play in the irreversible processes of complex systems responds directly to the problem of grasping aesthetic discourse and the practice of contemporary art in continuity. This has permitted developing an alternative to the structure of linear ontology for thinking and practicing artistic experimentation outside the paradigm of representation and a priori criteria. As the thesis has shown, the non-reducibility of complex systems demands that ontology is reconceptualised as a regime of radical finitude, where the barrier erected by

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[1] This dissatisfaction with current approaches to art practices is not academic, it stems from a personal engagement with making art in an experimental space outside the coordinates set by the categories of perception and traditional artistic disciplines and materials, which constitute the a priori criteria that define both the practice of art and its object. This is also not a concern about bad art, rather a reaction about a corrupted paradigm that is becoming embodied in the critical discourse and by contemporary artist without the due awareness.

entropy acts as an ontological constant, which forbids the passage to the ultimate and casts the notion of possibility in an entirely new light, as a self-constrained regime where dimensions and possibilities coincide in one continuous pattern, or dimensionality where aesthetics is inseparable from ontology.

More to the point, the thesis has concentrated on the importance of demonstrations of impossibility, which are at the core of both Gödel's logico-mathematical incompleteness and Prigogine's physical and epistemological non-integrability - as was seen in Chapter 2. The significance of this impossibility of totalisation consists in interrupting the homogeneity of ontology as well as breaking the equivalence of practices in the description of matter, nature and the universe. As discussed in Chapter 4, this induces the abdication of absolute claims for both science and ontology and shifts the hinge of sense onto the relevance of the specific practices adopted for asking questions and making sense of our engagement with the world, thereby expressing a genetic logic, or creativity, intrinsic to all languages, technologies and media.

Chapter 3 has described in detail how such finite heterogeneity is creative and constitutes patterns of possibility, which develop in self-constrained feedback loops, thereby generating parameters locally and irreversibly, rather than constructing sense according to a priori concepts; as is instead postulated in the paradigm of representation. Thus, rather than resigning to arbitrariness, possibility is both free from the grid of linear ontology and yet able to produce rigorous forms of coherence for sense and, in particular, art. In turn, this introduces a alternative understanding of materialism, where matter is not only that which is present as tangible mass, but everything that is relevant and matters in the present; that is, radical matter. This, as was seen in Chapter 4, undoes the conceptual frame that keeps matter and practice separate from immaterial discourses as the ultimate ontological structure, which too often tends to project a hierarchy biased in favour of the immateriality of concepts.

As seen in Chapter 4, the thesis found that an ontology that cannot look 'downward' to causes or ground can instead look 'forward' towards the diffraction of the present's

possibilities and their relevance. This brought the thesis to develop the concept of dimensionality, as a logic of continua that belong to the regime of sense rather than representing dimensions as external coordinates for both thought and practice. The notion of factish, which for Stengers acts as the epistemological expression of forms of coherence that emerge on the background of non-integrable finitude, provided a logic for these segments that see the practice, the meaning and value this implements as expanding simultaneously in a regime of reciprocity. In this light, questions of truth have had to yield to the diffractive logic proposed by Karen Barad, where the intersection of finite patterns generates consequences whose relevance constitutes the logic of sense and is ontologically genetic.

Following this, the overall suggestion of the thesis is that with the concept of dimensionality it is finally possible to overcome the last ontological bastion that distributes the universe of sense in material and immaterial categories, showing instead that the experimental logic of art is a practice of diffraction. Art works with the genealogies and the metastable images these produce of matter, objects, concepts, technologies and indeed other practices, rather than being caught in the dichotomy between medium and disembodied semantics in which traditional aesthetics had left it. That is, art takes entire patterns of possibility as both its material and subject matter, actively seeking adjacent possibilities from the organisation of the present. In this sense, practices that adopt genealogical patterns as their matter are no less *poetic* and *sensual* than those working with traditional disciplines rooted in a tangible material or technology. Indeed, reciprocal capture and self-constraints are ontologically creative and express a genetic logic of sense.

The significance of this methodology is that it allows articulating how art produces meaning and the language with which this meaning is expressed as well as the parameters according to which the configuration of art must be evaluated, as one series or segment of reciprocity. This frees contemporary practices from the colonisation of a discourse that is no longer able to address them. Indeed, thinking of art as a practice of diffraction also permits overcoming the entrenched image of art as representation. A tool, a medium, or a

discipline, are not neutral vehicles, but sets of dimensions that provide patterns of possibility for the artist to explore and challenge. The relevance of this radical materiality, and the breaking of the ontological equivalence of different media that this implies, points to an alternative grasping of the processes of making sense in art. Indeed, dimensionality supersedes the notion of *post-medium age*, with which an image of art identified only according to material disciplines defines the intangible practices that take discourses as their matter.[2]

The decisions of the artist do not take place in isolation as original acts upon matter. As continua, all elements of a practice are deeply embedded in onto-epistemological as well as political and cultural networks whose resonances constitute the material the artist works with. Defining what is transparent and what is opaque in these series or continua, so that a new pattern of sense can emerge, is the artist's poetic decision. Foucault had touched upon the same problem in his essay on Magritte's painting *Ceci n'est pas une pipe*, where he pointed out how the artist plays with the possibility of "*being* and *representing*" as series co-present in the same statement.[3] This is by no means limited to the semiotic interpretations of language and images. The definition of art as the matter of art was obviously Marcel Duchamp's interest in the famous *Fountain*. And the history of art as the object of art was the subject of Bruce Nauman's photograph *Self-Portrait as a Fountain* (where the artist's persona poses as the original fountain presented by Duchamp); or, more recently, Santiago Serra's *Wall Enclosing a Space*, where the transparent frame of the art institution is made opaque and provides the material of the work.[4] That is, the artistic practice acts by deciding where infinite regression can or must stop. This is the same genetic logic of approximation discussed Poincaré and Stengers: the impossibility of the infinite precision of measurement or absolute definition demands a decision; the decision engenders a degree of

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[2] Cf. Rosalind Krauss, *A Voyage to the North Sea, Art in the Age of the Post-Medium Condition* (New York, Thames and Hudson, 1999).

[3] Cf. Michel Foucault, "This is Not a Pipe," in *Essential Works of Foucault 1954-1984*, ed. James D. Faubion, trans. James Harkness (London: Penguin, 2000), 187-203.

[4] Serra's commission at the Spanish pavilion at the Venice Biennale of 2003 consisted of a wall almost entirely blocking the entrance, and the prohibition to enter for anyone not holding a Spanish passport.

approximation or roughness, which in turn makes both presence and sense. It is a creative logic.

In a certain sense Walter Benjamin had already individuated this problem. His analysis of the different demands and new modes of fruition brought by new technologies points precisely to the material relevance of the heterogeneity of practices. In "The Work of Art in the Age of Mechanical Reproducibility" Benjamin described very clearly how different technologies do not converge on the same concept and cannot represent the same meaning.[5] In fact, he saw well beyond the specificity of the shift that was taking place between the production of unique objects and the multiplications brought about by photography and cinema, and indicated that new practices are also regimes of reciprocal capture that produce a different kind of artist and public in loop with the pattern of the technology. Benjamin went as far as pointing out that expecting a new technology to produce figures equivalent to the artists working with classic disciplines would amount to a complete misrepresentation of new emerging practices. That is, it was quite clear to him that technology, artist, and public constitute a continuum that does not allow equating between heterogeneous regimes of sense. In fact, Benjamin's interpretation of materialism anticipated Stengers' argument about the non-equivalence of practices in the production of facts. Indeed for Benjamin becoming attuned to the relevance of the materiality of the practice was a fundamentally political problem. Avoiding the capture by a pre-existing structure of thought, which would suffocate and censor the practice's specificity and the new society this could express, was for him, as it is for Isabelle Stengers, a problem of resistance at the same time artistic and political. Forcing a technology into a pre-existing ontological structure or foreclosing the possibilities of a practice with an a priori image of truth, amounts to the imposition of one factish as absolute truth and to the exclusion of the

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[5] Cf. Walter Benjamin, "The Work of Art in the Age of Mechanical Reproducibility," in *Illumination*s, ed. Hannah Arendt, trans. Harry Zorn (London: Pimlico, 1999), 211-244.

rest in a generic category that ranges from subjective opinion to total heresy.[6] Capturing new technologies within older cultural structures amounts to the same ontological colonisation that Stengers exhorts the scientist, the philosopher and the artist to resist by learning to listen how the practice matters, so that it does not become foreclosed by the representation of the same.[7]

As seen in Chapter 4, this approach has the potential to turn the concept of aesthetics inside-out. In fact, the point is not to propose the 'aesthetics of complexity' but, as the thesis has shown, that aesthetics is complex; it is not the image of an object or a technology, but an active logic of coherence and relevance, which makes the accepted distinction of object and image (or ontology and aesthetic) meaningless. As the continua expressed by practices of reciprocal capture are creative, the questions *does it matter? how does it matter? and for whom it matters?* are artistic questions as much as onto-epistemological problems. They belong to the practice of art, functioning outside a definition on the basis of the medium or technology, which reduces the materiality of art to a self-referential exercise. Yet, the mattering question cannot be oriented simply towards the environment surrounding the work. The fact that art matters, and that it matters thus rather than otherwise, and for this specific group of individuals, can only take place and succeed if the ways in which it matters are played with poetically; that is, they are considered the material of art, as the matter that matters. Therefore, after relevance and diffraction, the category that names art's logic in a regime of dimensionality is *curiosity*.[8] An act that turns a given pattern of dimensions into a question, challenging the organisation and distribution of the present *thus* and always wondering what *otherwise* would be like. In fact, curiosity is the engine of art in metastable equilibrium between the genealogies of the possible and its

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[6] Such was Benjamin intention to resist fascism by understanding how technologies produce sense in heterogeneous and local ways; Cf. Ibid.

[7] Cf. Isabelle Stengers, "Wandering about Materialism," in Levi Bryant, Graham Harman and Nick Srnicek eds. *The Speculative Turn; Continental Materialism and Realism* (Melbourne: re.press, 2011), 368-380; and Isabelle Stengers, "The Cosmopolitical Proposal," in Bruno Latour and Peter Weibel eds. *Making Things Public*, trans. Liz Carey-Libbrecht (Cambridge, MA: MIT Press, 2005) 994-1003.

[8] Cf. Sue Golding, "Curiosity," in *The Eight Technologies of Otherness*, ed. Sue Golding (London: Routledge, 1997), 10-28.

open present; thereby replacing the traditional category of representation and the narrative of the artist's intention to express a specific meaning, for the openness of adjacent possibility.

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