Quantum Ecologies in Cosmological Infrastructures: A Critical Holographers Encounters with the Meta/Physics of Landscape-Laboratories

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Quantum Ecologies in Cosmological Infrastructures:

A Critical Holographers Encounters with the Meta/Physics of Landscape-Laboratories

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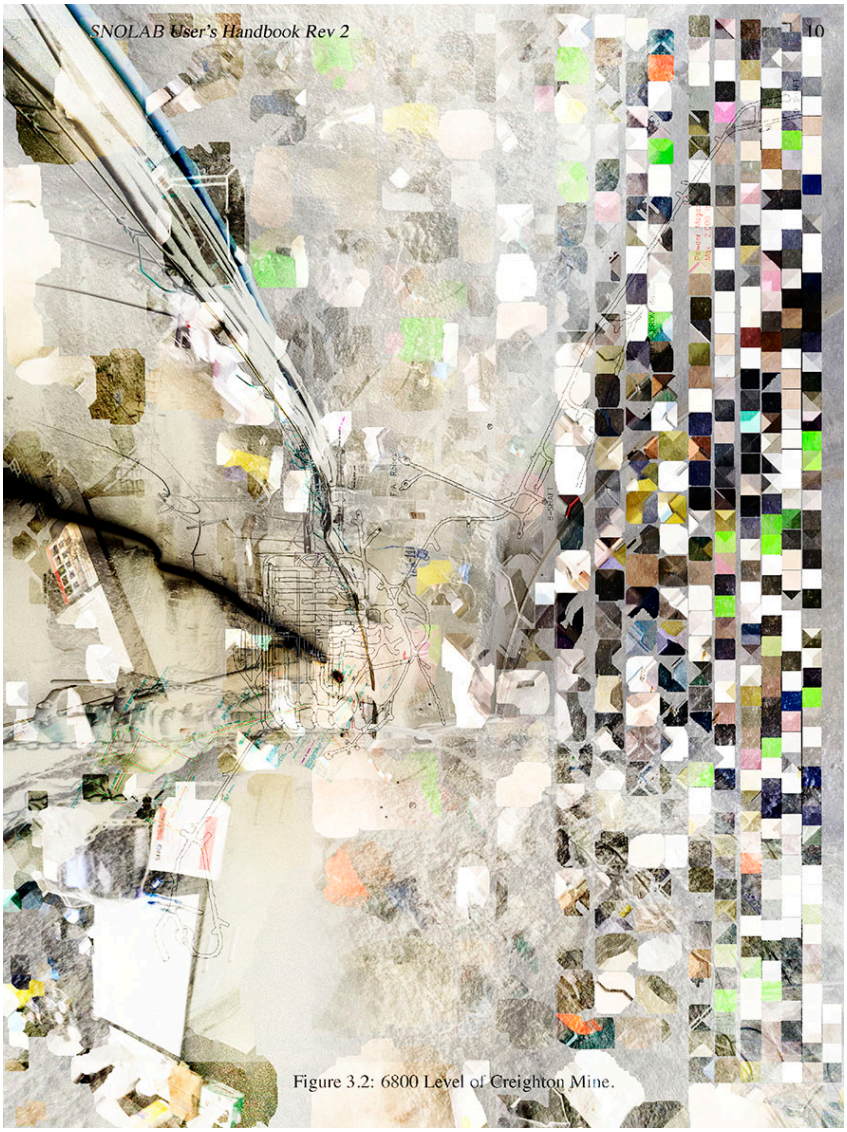

Abstract

Quantum Ecologies interrogates the role of physics in the construction of an indifferent and disenchanted universe. It explores conceptual resonances within and between new materialism, Indigenous philosophy of place, science fiction, and art. Quantum Ecologies recognizes that the world is alive and wise and considers relevant modes of responsible address within and as the Earth. Through theoretical and historical analysis, site based research and a/v installation *Quantum Ecologies* has developed the heuristic of the 'holographic' as a way to attend to the multi-temporal, co-present, and multi-scalar pluralities and layers of knowing, agency, and landscape. This feminist, anti-colonial art-science framework for critically engaging (physics) sites and philosophies addresses the scientific cosmology of the West that (inadvertently) legitimates the exploitation, dispossession, and extraction of Earthly beings and bodies. Holography as critical interferometry is applied to experimental sites and assemblages known as 'landscape-laboratories' as a mode of both reading and (re)writing them. My research and field/work has taken place in remote environmentally protected sites that are entangled and instrumentalized as cosmological sensing arrays, experimental nuclear fusion energy, or dark matter particle physics laboratories in Russia, France, the UK, Germany, and Canada. By thinking through the weirdness of these planetary quantum assemblages alongside sciences genealogies in magic, alchemy, and mysticism I argue for the necessity of 'another science' that is situated, compassionate, and responsible. Quantum Ecologies proposes a plural, poly-perspectival assessment of place, where accounting for the promiscuous *more-than* of materials, sites, forces, and energies is a necessary and continuous (re)configuring of meta/physics and respectful anti-colonial engagement with Land.

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I declare that all the material contained in this thesis is my own work.

Acknowledgments

This thesis would be absolutely unthinkable without the kind support, mentorship, and encouragement from generations of artists, families, and friends scattered across this tiny/huge planet. I am eager to thank my incredible advisor, friend and colleague, Dr. Neal White who invited me into this academic world five years ago while at a conference at the RCA London. There people were discussing the political and legal implications of solar powered floating sculptures I had been peripherally involved in. Neal has always been in my corner, readily available, and so very supportive in times of ups and downs. I couldn't ask for a better guide, friend, and mentor through this bio/geosemiotic terrain. It is with a steady heart and mind that I extend deep gratitude to him, an incredible artist.

That conference in 2016 at the RCA was convened by two big influences in my life and work: Sasha Engelman and Tomás Saraceno. Their dedication to the sky and atmosphere through the Aerocene project, which is now a Foundation, expanded my conceptions of what is possible. Sasha and I met Neal already when we were presenting a joint paper at an Art and Dark Matter conference at Lancaster University where Neal was also a presenter. The paper Sasha and I collaboratively wrote and presented there was due to her introducing me to the work of Karen Barad. They helped me realize my intense interest in physics and neutrino (detectors) could be directed towards my mutual interests in critical studies, philosophy, and experimental arts. I have Sasha to thank for helping me figure that out and offering so much guidance along the way.

Aerocene, a project initiated by my friend and mentor Tomás Saraceno was (re)born while we were engaged in developing and teaching a new arts curriculum at the Technical

University of Braunschweig entitled ‘Becoming Pilot’. Between 2014 and 2016 Tomás invited me to develop and deliver an experimental arts pedagogy with him for architecture students learning to live in the Anthropocene. In this time we shared many ideas, gestures, meals, and experiences that have shaped my thought and being in the world. That time has had innumerable impacts on my practice and ideas of aesthetics, on my ideas of what art can do and be. “*Everything* can be reinvented”, Tomás convincingly relayed to me, and I’ve held onto that in thinking art, science, philosophy, ecology, gender, and society. Thank you, my dear friend, my brother.

I came from a very small village, a hamlet in settler colonial Canada - a territory that is still to this day a site of Indigenous-Settler contestation. That rare and unique land is in my blood and DNA, in my dreams and music, and I can’t use words to express how that living landscape and its deep dark skies impressed, imprinted, and embedded me with so much love and care for nature and their unspeakable, radical wild(er)ness. I want to acknowledge, though I no longer live on those lands, but because I was reared there, the traditional keepers of the Land: Meegwetch/Nyawen to the Anishanaabek and Haudenoshaunee people and ancestors who deserve so much better from the settlers they trusted to share the land with them so many generations ago.

To my parents John and Terri who had the caring forethought to move us from the suburbs out into the rural landscapes of the Grand River valleys, the ‘place of the Willow trees’ or *Oshwe|ken* in the Mohawk naming, I give my lifelong love and thanks. They brought us up far from cities or towns, deep in the forests and rivers of Ontario, somewhere embraced between the Great Lakes of Turtle Island. I open my heart to them again and again for their

enduring care, and for letting me forge my own precarious and tentative path in a highly regimented world. To my brother and sister who are also great supports, though we are distant we are connected, and I cherish you and y/our families. Lots of love to the kids! I also have another set of parents, 'my two dads': the artist couple Johannes Zits and Ed Pien whom I worked very closely with during my last years in Toronto, and whose incredible spirit, joy, ethic, and generosity helped to transform my understanding of art and Life, to see how intrepidly beautiful and magical it can be. To more dinners together!

The incredibly talented artist Caitlin Berrigan who I originally met while we were both Fellows of the Akademie Schloss Solitude artists' residency program in a Forest Castle of Stuttgart gave me amazing comments on what is now the fourth chapter in this thesis. While walking through that forest in southern Germany together in the COIVD summer of 2020, her astute resonance and knowledge in our Venning fields of interest and critical poetics led me to see the thread which helped pull it all together, and I can't thank her enough, though I will keep trying.

I have had the great pleasure of collaborating with a team of physicists in Munich after a chance encounter atop a frozen lake in Siberia. The amazing, kind, daring physicist folks at the Technical University of Munich whom I've been collaborating with through the course of this thesis: Dr. Elisa Resconi, Petra Riedel, Stefan Schönert, Kilian Holzapfel, all of the SFB1258 Neutrino and Dark Matter Group: Thank you for your enthusiasm, energy, languages, research, and willingness to think beyond disciplines. This is a really incredible activity to partake in – transdisciplinarity: opening so many possibilities - and I give deep, caring recognition for your trust and support through the years. Friends and students that I've worked with at the

Akademie der Bildende Kunst Munich: the artist Diogo da Cruz for all of his support with the "SFB42" interdisciplinary artist and physicist group we worked and travelled together with to the peaks of Italy where a mountain is an advanced technology. To my friends and partners in crime who have scattered over the face of this celestial planet – you know *I Love You*; you keep me so inspired with all you do. I miss you and hope to see you again soon (dancing).

Also a big *shout out to the Earth* and its many forces and entities! From the elements, materials, times, beings to the landscapes, stars, and universes that this field/work and re/search practice continues to learn from (If this research were music it would be in the genre of *Earth-Core*).

To the rocks,

to green-wet things

All waters

and their bubbles

To the vast unknowing

expressed but never captured

in music, dance, art, food, laughter, love, sex, friendships

To the Lands that have opened me

where spirited winds rush up from the ground

To the wise, unprecedented entities of Earth's places and bodies,

their many portals and gestures beyond-beyond

And to the particles which defy reason or models

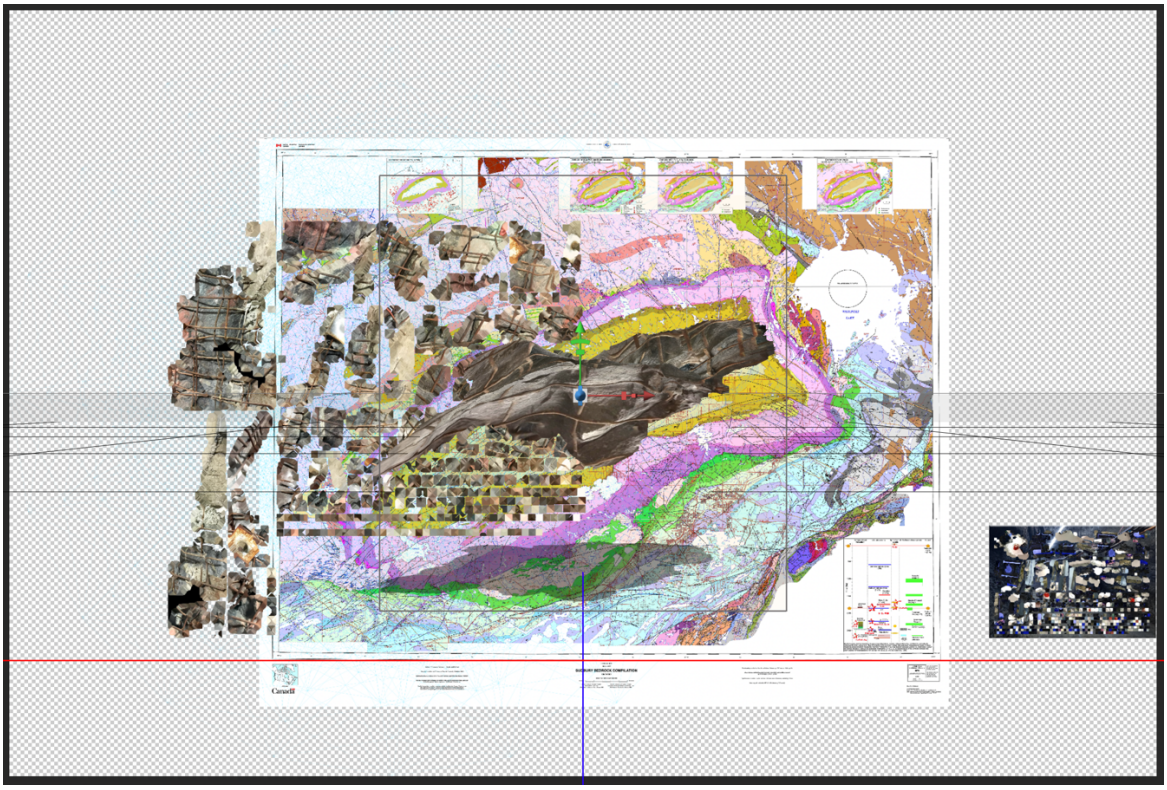
revealing how there is so much more that we do not and cannot know

I give perpetual felicitations

Indeterminacy, uncertainty, and contingency

are strengths rather than weaknesses here

Chapter 1: Introduction



02. *Untitled (meteor/basin collage)*, Jol Thoms, 2020.

"To study space and time in their extremes is not necessarily to transcend politics; it is to get a clearer fix on what is at stake […] in an age of subatomic nuclear reactions and nanosecond computers, the Hubble telescope and the big bang. Not all communication is human communication. Animals and machines, atoms and the earth, the seas and the stars are themselves full of curious communications, and our efforts to have intelligence with such entities reform our own practices as well. A vision of communication committed to democracy cannot foreclose on entering into intelligence with radical otherness, including the earth, other species, machines, or extraterrestrial life."

(Peters, 2003, p.399)

1.1 Terraforming Meta/physics

My artistic-research practice approaches environment and ecology through theoretical and historical analysis of the metaphysical concepts of nature, technology, space, and the human in Western modernity's scientific cosmology. My fieldwork has generally taken place in the domain of contemporary experimental physics and physical cosmology and resonates in the friction between a mechanistic, reified universe of classical physics (which remains deeply influential in modern society), and the more vibrant, fuzzy, contingent ontologies revealed by quantum theory and phenomena. These disciplines are where I have found alluring concepts, processes, objects, trajectories, tools, entities, and sites that have managed to push my thinking beyond scalar, quantifiable logics or sense allowing me to produce challenging artworks and experimental theories capable of holding both quantitative and qualitative knowledges together at the same time. My deep concern for the environmental and ecological health of the planet and the eco-social relationships that these concerns entail have led me to strange, remote, vast, and odd situations, assemblages and practices that are, by their hybridity or unthinkability – their non-standardness – in resonance with an artist's sense of an expanded perspective or pursuit. Having approached the development of my research within these territories where protected landscapes meet physics laboratories in novel, conjoined, even indistinguishable ways, and treating my research and practice as an unfolding process, an 'experimental system' (Rheinberger, 1997) for generating methods, concepts, or perspectives, I have relied quite heavily on, and desired, a robust theoretical background. To this end I have been engaged in extradisciplinary Anthropocene

Studies, specifically where feminist[1] science studies, post-humanities, and environmental studies intersect in new materialist philosophy and anticolonial 'critical place inquiry' (Tuck 2014). My practice is a form of play/study/analysis that diffractively reads these multiple disciplines and theories through particle physics sites with an emphasis on the non-human agency of the elements, planetary bodies, apparatuses, and particles. My work has taken the form of published articles, interdisciplinary workshops, and experimental a/v installations. Over the course of developing this thesis, *Quantum Ecologies*, discovering its logics and methods from within the text, the landscape, the discussions, I have developed new concepts for understanding some of the critical social, ecological, political, and philosophical challenges that terms like Anthropocene or Capitalocene acknowledge and announce. This is a body of work in resonance with what Karen Barad (2007) terms *meta/physics*: the metaphysical implications of quantum physics phenomena for outdated western concepts of nature, knowledge, technology, and being; for touch, dance, and love.

My fieldwork has primarily taken place in the laboratory-landscapes of the experimental (rather than theoretical) fields of physical cosmology, astroparticle physics, and the alternative energy sector of plasma and fusion physics. Fundamental to my focus in each of these similar yet distinct domains is an awareness of the challenges that the 'planetary multitudes' (Clarke & Szerszynski 2020) face in an age of exasperated global inequality, catastrophic climate destruction, and accelerated resource depletion (which are here considered intimately entangled 'matters of concern' [Latour 2008]). Through my research, methods, and outputs I implicitly and explicitly ask

[1] "I get embarrassed when I say feminism and people do not think *revolution in the service of every living thing".* Olufemi, L. 2021. *Experiments in Imagining Otherwise.* (p.13).

if there are processes or concepts that can be found within physics or within the stories and allegories physics uses, to attend to some of these critical issues facing a divided, sick, and warring planet. While considering this question – if physics can or does contribute to eco-social thought either implicitly or explicitly – I have developed and maintained a critical perspective on the (inadvertent or otherwise) philosophical contributions of this 'master discipline' that presumes to define and describe the 'facts' of nature.

Over the course of my creative-research thesis development I have been very privileged to visit a number of physics laboratories and experimental sites, researched the histories and philosophies of science, of epistemic violence attributed to this discipline, participated in art-science exhibitions internationally, created new works, published texts and articles, and lead a number of interdisciplinary arts, science, and research workshops and fieldtrips in Germany, Italy, and Canada. What I have learned in these years is partially explainable with language, yet much of it remains in the domains of situated, felt, and embodied knowledge (Haraway 1988), the affective registers where artworks so thoroughly and powerfully reside.

Each chapter in this dissertation is aligned with a specific audio visual/installation work and its specific site related to a specific experimental physics practice. Each chapter begins with a performative description of the site, practice, and outlines the type of engagement I've had within it while describing my underlying motivations for thinking with *and as* these embodied sites/experiments/particles/assemblages. Each networked object, each entangled entity in this sense, has been considered as and become - for me at least - a form of thought: structures for thinking the 'ethics of being in knowing' (the ethico-onto-epistemology suggested by Karen Barad

in *Meeting The Universe Halfway: Quantum Mechanics and the Entanglement of Matter and Meaning* [2007]). These are simultaneously ethics enmeshed and described by contemporary ecological thought. The audio-visual or creative elements of these chapters push the material further into more situated and felt experiences, gesturing towards further questions while resolving others that may not be resolvable in text. They operate beyond what written language alone can do. These are of course the key arguments for the necessity of artistic-research practices in Higher Education.

One of my main practice-led questions and motivations has to do with an undeniable fact of history: over centuries of development the articulation of the modern sciences has constructed and upholds the deeply flawed notion of an *indifferent* universe, a disenchanted world and reality, where the liveliness of planets, planetary bodies, stars and nebulae, lakes and rivers, forests, and salt flats, are all essentially *dead*, without 'purpose', knowledge, thought, or *life.* Millenia of ineffable experiences of place, of planets and rocks, minerals and flowing bodies which have informed responsible eco-spiritual practices are relegated outside of 'meaningful', 'factual' observation, measurement, or quantitative description favored by the hegemonic epistemic model of modernity.[2] If it is undeniable that this reified cosmos of scientific cosmology is a central pillar of modernity, then modernity, in its colonial universalizing logics, has indeed contributed to the production of a universe devoid of life or spirit, therefore qualified for exploitation and extraction; worlds that can be polluted without respite, that can be disregarded as 'nothing', as 'base matter'. There is of course the opposite side to this narrow conception of the sciences,

[2] I also refer to this later as *scientism*, the belief that only quantifiable phenomenal experience is 'real', disregarding millennia of human practice and experience with animate, vibrant, living worlds and universes.

which is that the sciences are simultaneously the practices that allow humans to observe and describe the very problems we're facing and are absolutely necessary for finding a way to ecological equilibrium, or at least less toxicity and barbarism. I have been eager to find a way, to ask if it is possible, to reinsert and interweave a knowing, learning, communicative universe that can be communed and cared for – that is fundamentally and essentially *alive* from the micro to the meta-macro scales of possibility - back into the very fabrics and narrations of science itself. To do this I've found my way inside institutions and laboratories to compose complementary posthuman narratives using apparatuses and assemblages as models for an updated form of knowing. Tracing the intersecting matters of these crossing universes of quality and quantity, animism and mechanism I have rediscovered what is at stake and what is missing from contemporary accounts of knowing and being in the dominant western colonial paradigm.

Four years ago, I began the journey of this doctoral project, with a clear enough path and a motivation to develop and uncover a methodological innovation in art-science encounters and research. What I've developed in this time is a new series of works, international collaborations, and a speculative lexicon for (re)considering the new categories of thinking and knowing that my field sites offer. As the body of this text unfolds, and as my fieldwork developed and expanded to new sites and situations, new factors in my methods arose and are described, new theoretical tools of analysis bloomed. What I have come to learn is that there are similar destinations that posthumanism, new materialism, and quantum physics share with Indigenous philosophy and epistemology, and that there are still similar descriptions between the latter and some classic science fiction, such as Stanislaw Lem's *Solaris* (1962), Andrei Tarkovsky's *Stalker* (1977), and Olaf Stapledon's *Star Maker* (1937). These lines are brought together again in the next section (1.2)

while thinking about the sentience of nonhuman bodies and the influence of Indigenous philosophy of nonhuman agency alongside western conceptions of 'vibrant matter' (Bennet 2010).

Two chapters of my thesis – the 3rd and 5th – are devoted to vast planetary-scale remote sensing assemblages found in the field of neutrino (and dark matter) physics: networked apparatuses embedded in elemental planetary bodies. The imperceptible particles to which these apparatuses are directed are also generative in their invisibility and their anarchic ontological behaviors, complicating simple readings and transforming scientists' own conceptions of their discipline, of reality and matter. The second chapter hinges on 'clean' nuclear *fusion* reactors', alchemical thought, and the 12th century mystic-saint Hildegard von Bingen. It engages the allegorical mode of physics communication as it is specifically wrapped up in large-scale experimental energy projects that 'harness the power of the sun'. An attention to the elemental, geological media in these sites and assemblages roots them back into environmental and ecological considerations while directing them beyond their explicit fields of study, situating them back in the matters of Earth and place.

What occurs through the written portion of the thesis is an unpacking of the physics philosophy or meta/physical implications within these eco-techno-cosmo-logical artefacts and assemblages. Through interdisciplinary analyses of the material-discursivity of these assemblages I confront and explore some of the pressing issues discussed in recent scholarship of Anthropocene Studies as well as their implications for concepts of time and agency in artistic and theoretical practices.

1.2 Nonhuman Agency in Indigenous Epistemology and Science Fiction

> "In short, what if scholars took the narratives of Elders and traditional Indigenous knowledge holders seriously about an intimate vastness of wisdom that percolates through the layers of physical and metaphysical time and space in sentient landscapes?" (Marker, 2018, p.454)

The epitaph of Martinican scholar and celebrated poet Edouard Glissant reads, *'Nothing is true, everything is alive'* (Loichot, 2013), gesturing beyond Western epistemic understanding, and resonating with millennia of folk and traditional knowledges.[3] We could say that what this complexly simple and playful phrase evokes is at the heart, implicitly, of so much scholarship and artistic practices today, especially those which seek to recognize and release agency back out into the many worlds, beings, and entities of Earth and Cosmos.

Far beyond the mere 'human' container,

far beyond mere biological life.

This thesis' slow development through alchemy and Magic (Campagna), through Science Fiction, has also thought tangentially through the 'ontological turn' in anthropology, a turn motivated by careful work within Indigenous communities of the South. The ontological turn often associated with Viveiros de Castro, Philippe Descola, and Bruno Latour has inspired a lot of work in

[3] This is written on the grave of Glissant See, for example: https://carlosmonleon.com/Nothing-is-true ; https://dutchartinstitute.eu/page/8255/going-space-caecilia-tripp-and-edouard-glissant-at-clark-house-bombay-10 ; https://agyu.art/project/winter-2018-newsletter/)

New Materialist philosophy (Object Oriented Ontology, Posthumanism, Actor Network Theory, and Agential Realism) that recognizes the *vibrancy* or liveliness of matter and Land. Philosopher of *cosmotechnics* Yuk Hui writes that the "ontological turn is an explicit response to the ecological crisis or ecological mutation… proposing to take these different ontologies seriously, and to undermine and adjust the dominant European discourse of naturalism, in order to search for another way of co-existence" (Hui, 2017, p. 4). That the *Land* that we live on and from, the Land that the laboratories I intra-act with are embedded in, is alive and knowing is the basic understanding in many different Indigenous philosophies but remains difficult for post/modern citizens to realize due to centuries of systemic eradication and the enforcing of commodity fetishism as colonial education (socialization/proletarianization). Despite infamous science fiction novels and films, or even hybrid scientific concepts like *Gaia* that attempt to elicit the same understanding (though systematically), Northern capitalist economies ruthlessly divert our most basic knowledge of being a part of a larger living whole. How could we continue to brutally metabolize the earth's bodies for profit if we understood it as (a) complex (extra)terrestrial being(s)?

In 1937 author Olaf Stapledon published an astounding and vivacious novel of a man's journey-dream through the cosmos and its many types of planetary beings. In Stapledon's epic *Star Maker*, as the journeyer travels through space caught in some type of trance or mystical dream, he encounters other worlds, melds into the minds and communities of alien creatures, and expands into a form of consciousness that witnesses the lives, communications, and dances of planets and stars, eventually to peer into the reality of the Star Maker itself. Stapledon wrote fiction that recognized cosmic beings, stars and planets *as alive,* living beings capable of complex

emotions, senses of purpose, and desires. Stanislaw Lem's *Solaris* (1962) also offered its readers a confrontation with the limits of human reason by introducing a sentient ocean planet that human beings strive to communicate with, but which always evades scientific capture. By some non-coincidence, the scientists aboard Luna147, the artificial satellite orbiting Solaris, aka Solaris station, are met with living memories from their past, haunted by beings who appear to them in solid form, but which are made entirely out of *neutrino particles*. The great filmmaker Andrei Tarkovsky, who made a well-known film based on Lem's eponymous novel that confronts people with the limits of their ability to communicate and reason with more-than-human beings, also directed a masterpiece of science fiction based on the novel *Roadside Picnic* (1970) by the Russian authors known as the Brothers Strugatsky called *Stalker* (1977). In Stalker, a dangerous, unpredictable, possibly living landscape holds powerfully dangerous abilities and many secrets. The protagonists – an artist, a scientist, and a 'pagan of the zone' – the so-called Stalker – (along with a ghost dog) carefully proceed through this alien landscape in hopes of changing their lives, perhaps even changing the world. They meander their way through a living landscape, sensing it by throwing bolts with white strands of fabric attached to them – waiting – listening – observing how the land shifts, changes, or groans, directing them this or that way – carefully. All to make it to a room that may grant the journeyers deepest wish.

In the Western canon of science fiction we have many resonant ideas that Venn with some Indigenous philosophies and epistemologies of place. Quantum physics, its emphasis on the role of the observer and the intra-activity of apparatus to land, mineral, and body, also resonate with expanded ideas of nonhuman agency that science fiction and some 'Native science' (Cajete, 2000) also propose and practice, entangled in vast networks of influence. In contemporary fiction we

might think of Jeff Vandermeer's *Annihilation*, also made into a major motion picture, where a landscape becomes radically alien and dangerous after some type of unknown cosmological encounter. Indigenous and folk traditions from across the globe have known from experience and embodiment within environments that the land is entiative, life giving and communicative, which is why scholars in these traditions capitalize *Land* to denote its Being (Rosiek et al. 2020; Tuck, 2014; Marker, 2018). Terms like animism and, perhaps to a lesser degree, posthumanism also elicit this knowledge or gesture towards it, alongside new materialisms. It is through my engagement with quantum or 'post classical' physics, posthuman literature, agential realism (Barad 2007), and 'experimental systems' (Rheinberger, 1997/2013) of openness to materials at sites in remote regions (their apparatuses, subatomic particles, elemental and planetary bodies) that I have come to more fully understand my own experiences – that places are alive and aware – physically, emotionally, spiritually, and intellectually. That this knowledge of a living knowing world has been recognized and understood by Indigenous philosophers for millennia cannot be overlooked or erased from our scholarship in fields of non-human agency and new materialism (Rosiek et al. 2020; Tuck, 2014).

In a recent article authored by two white settler scholars and a traditional Kickapoo tribe Member (each followers of Karen Barad's agential realist approach), they have requested agential realist and posthumanist scholars to respectfully engage with Indigenous philosophy of place (Rosiek et al. 2020). In a similar area of concern Lummi Nation member and scholar Michael Marker also carefully prompts us to recognize the similarities between Indigenous philosophy and quantum theory and has led me to other Indigenous philosophers who have already written and spoke about this in the past (Marker, 2018; Cajete, 2000; Littlebear, 2015). Throughout this thesis,

I carefully think within and alongside Land not in a typical position of settler appropriation or exploitation (though the reader can decide my position for themselves), but rather in parallel with the knowledge that is wise to the Earth(s): their green-wet / sunlit rock / vivaciousness *heaving*. I do this by navigating western historical and contemporary resonances alongside 'emplaced' philosophies of Indigenous scholars and their metaphysics (that have always included agential, sentient geographies) (Marker, 2018; Rosiek et al. 2020; Tuck, 2014).

> "In Indigenous cultures, the landscape is more than simply a container for human history. It is the mind of reality shaping the stories of time and space. The proportions of events and the meanings of the ecological relationships between humans, animals, plants, and geologic forms are undivided from the physical experience of, as many Elders put it, 'being on the land.' Modernist social systems and knowledge taxonomies have too often followed a colonialist recipe for seeing the landscape as an inanimate surface for extracting, shaping, and constructing the artifacts of progress. This commodification of landscape persists in both public consciousness and environmental policies: oil extraction, mining, and massive hydroelectric dams are just a few examples. Place, in this Modernist ontology, has been abstracted, divided, and bordered into a component of reality rather than the progenitive holism that Indigenous knowledge systems begin with." (Marker, 2018, p. 453)

Significantly, the authors of *The New Materialisms and Indigenous Theories of Non-Human Agency: Making the Case for Respectful Anti-Colonial Engagement* (Rosiek et al. 2020)

acknowledge that "different communities may come to similar understanding of the world through different conceptual paths", however:

> "[N]ew materialist scholars' enthusiasm for agential realism could, by failing to acknowledge and seriously engage the Indigenous scholars already working with parallel concepts, end up reinforcing ongoing practices of erasure of Indigenous cultures and thought" (Rosiek et al. 2020, p.2).

In this way, the authors insist that *Respectful Anti-Colonial Engagement* is possible with Indigenous Theory (Tuck, 2014; Weheliye, 2014; Todd, 2016), and that settler/colonial citizens of North America and Europe/UK doing research within new materialism must overcome their aloof (white) fragility (or superiority) to approach the complex terrain of relations and rich cosmologies so as not to (~~inadvertently~~) reinforce the ongoing and historical erasure of Indigenous thought and communities. Finally, "Ignoring Indigenous theorizations of non-human agency involves a performative contradiction with the emphasis on the ethics and politics of social inquiry claimed as a promise of new materialist philosophy" (Rosiek et al. p.3). How I've come to my understanding and engagement with this knowledge has been circuitous, but it is one of the most significant challenges which has arisen over the course of this study, allowing for significant sets of encounter through the process.

Although there is a lot of physics within my research-practice, there is similarly a lot of *Land* and *intangible ineffitude.* There is water everywhere; norite and other forms of granite and rock; elements, minerals, metals, gases, lakes, mountains, ice shelves, forests, oceans – all as lively

agents and 'sentient topologies' (Marker 2018). Staying with the troubles of physics allows me to put my own knowledge and experience (at risk) to use against settler/colonial logics and interpretations. My embeddedness within remote physics landscapes iteratively multiplies generative and excessive possibility while uniquely positioning my research transformatively within: towards more multivocal and plural engagement and growth, both in the institutions, and in the aesthetic mode.

> "Chandra Mohanty (2003) observes that as we develop more complex, nuanced modes of asking questions and as scholarship in a number of relevant fields begins to address histories of colonialism, capitalism, race, and gender as inextricably interrelated, our very conceptual maps are redrawn and transformed." (Tuck, 2014, p.46)

As we move through the complex terrains where 'cosmologies cross', where mathematical sciences and enspirited lands and places entangle and reinforce one another, where lakes and mountains are understood as living and performative, engaging in the co-production of society and culture, we have to be able to sustain the compossibility[4] that that which is quantifiable has truths which are not physically measurable, and that these truths are equally powerful and important – they still require our attention, care, & commitments – our engagements, rituals, and protection. For, in a world of ongoing eco-nomic and eco-logical crises, 'It matters what stories tell stories' (Haraway 2016, p. 35, riffing off Sandra Harding). Reality is much more than what young

[4] Compossible refers to the possible compatible conjunction of what may have been considered 'mutually exclusive' phenomena/properties. Later I will refer to the 'continuum' of im/material or un/certainty, for example.

human/sapien neocortical minds can experience, perceive, or understand of it - but the horizon is wide, deep, near, within, beyond: Lets travel… lets tell better stories about what matters, because it matters.

1.2 Where Am I Coming From?

Considering the importance of situating practices in the sciences, locating them, embedding them in the material-discursive worlds of Earth, it is equally as important for researchers to situate themselves for readers to know from what perspective or position their interlocutor is coming from, to uncover any potential or implicit bias, to know with what authority one speaks from – or does not. In the next pages I give an account of my background and history so that you have a better understanding of my voice and position.

I was born in a small village of settler Canada in the 1980's to a young family of laborers, the youngest of three. I played a lot of sports (though I showed a lot of interest in music), had dogs, and we heated our house from fireplaces and wood stoves. I became interested in punk music that was overtly political and anti-fascist in my early teens, and the No Logo (Klein 1999) spirit still resides in me. Despite dropping out of high school in the final semester to help my father's business I was the first in my family to attend university, relying on student loans, telemarketing, and industrial painting jobs to be able to afford it.

I am a nearly 200 cm tall white man who has had all the privileges that go along with this identity in settler societies. Aside from being mistaken as a basketball hero, my journey through life has been safe and comfortable, regardless of my difficult economic situations, because I benefit from the security that is afforded to white men in western society. I consider

my gender identity to be fluid or non-binary but am generally read as CIS gendered. I have struggled with depression and anxiety for most of my adult life, some of the darkest moments occurring through the course of this research.

I came to artistic practice quite late, and by a happy accident, but quickly became enmeshed in the scene of Toronto due to my quick and fluent understanding of it, as well as my experience in audio production which I gained from having had been involved in experimental music since my teenage years. Within my first year of studying art history and studio practice at the University of Toronto, shifting to these disciplines from International Relations & Peace and Conflict Studies, I was working with some of Canada's most significant senior artists, writing large award-winning grants and producing audio and video for significant touring installations. It was in this time that I was drawn to performance and video, and specifically interested in the history and development of structuralist film, whose traces still play through my aesthetic sensibility, always with an emphasis on the structures and materialities of the media and concepts I am working with and through.

From Toronto, nearing the end of by Honors BA, after escaping a traumatic and violent relationship, I sold all of my collections of records, CDs, DVDs, video cassettes and books and, on the advice of senior artists, traveled to Berlin, Germany without knowing anyone or having a place to stay. I first landed in the Venice Biennale in 2009 as a volunteer for the Canada Pavilion (who were showing Mark Lewis) during the opening week and then travelled to Berlin where I stayed for three months. From this journey I was invited to work in the still growing studio of artist and architect Tomás Saraceno. In the studio of Tomás I wore many hats and travelled the world as a project and installation manager for various exhibitions at a wide range of

institutions. These experiences necessarily imprinted in me a sense of responsibility, a certain standard for complexity, and an aesthetic conditioning that is difficult to receive in a normal academic setting. While working full time in Studio Saraceno, I began attending the Städelschule in Frankfurt AM – an intimate art academy with well-established faculty. There, the Turner Prize winning, and quite down-to-earth artist Simon Starling was willing to let me attend his class, and it was there that I began to dive into a European conception of art practices and to transform, for better or worse, through its subjectivization processes. In Simon's class I was really challenged in how I thought and worked, which at times stalled my progress, while refining my sensitivity and artistic concerns. It was an invigorating time where I was able to meet and work with young emerging artists from all over the world, developing lasting relationships that I cherish to this day.

While in the class of Simon I developed a body of performance lectures that were inspired by higher dimensional geometries, consciousness studies, and the history of scientific development through radical doubt, the so called *epoché* of Husserl. I built hypercube sculptures and visited and filmed various German telescopes, including the 'Einsteinturm' in Potsdam, a quite magnificent modernist architectural apparatus, a solar telescope designed to prove or disprove Einstein's theory of relativity (though Eddington succeeded in doing this during an eclipse before the completion of the magnificent tower).

After finishing my MFA equivalent training in 2013, and still working as project and research manager in the Saraceno studio, in 2014 I was invited to develop and teach an art course with Tomás for young architecture students at the Technical University of Braunschweig. We quite intuitively produced a course that focused on issues of climate

change, informed by the then still emerging Anthropocene Studies, a truly radical pedagogy informed by guest lectures, group exercises, and a truly interdisciplinary and experimental spirit. Every Friday we travelled by train and bus to a German forest where our old reconstructed modernist experimental cement factory served as a remarkable setting for working with 200, mostly BA students. For 5 hours we would lecture, dance, watch, listen, explore, discuss, picnic, produce, and think together. All of these experiences from Canada to Germany, and now London, inform who I am, and give you a context and background to who you're hearing from here in these fragments and texts.

1.3 Re/turning to Structures and Patterns: Outline

My PhD journey gained a lot of momentum (although I didn't recognize it at the time) in Siberia, deep in the winter landscape atop a frozen lake – a lake which happens to be the largest and oldest freshwater lake on the planet – Lake Baikal. There I collected sounds, images, impressions, and *mineral samples*, from the territory of the world's deepest lake, bracketed on the eastern shores by the Ural Mountains. While its deepest region was being transformed into a new genre of experimental and *subaquatic* telescope, a 'neutrino detector' that has been specifically located in the northern hemisphere to be directed towards the blackhole at the center of our galaxy, I happened to meet a young German physicist who had come to Baikal to test new calibration objects for these vast and complex submerged matrixial telescopes. It was there that a friendship began with Kilian Holzapfel and new collaborations soon developed with the Technical University of Munich's physics department, specifically the *SFB1258: Neutrino and Dark Matter Group* led by the inimitable visionary Prof. Elisa Resconi.

I left directly from Irkutsk, Siberia to an interview in London for the studentship that indeed allowed me to pursue this research. After dropping off some camera equipment in Berlin, and meeting with CREAM professors, I travelled to a geography conference in Boston, then to Canada, where, in my grandmother's basement, I received the heart-warming good news of being accepted and being granted an international studentship and scholarship. Since then, I have been continually working through that Siberian material, turning and returning to it. It now comprises the first chapter of this thesis. After deep pursuits to find relevant ways of working with and forming that material, a few name changes, some published texts and an exhibition in Pisa organized by the director of the European Gravitational wave observatory, the title, *A Borderline Conception Lying at the Extreme Edge of the World of Appearances,* found in a book co-authored between Carl Jung and Nobel prize winning physicist Wolfgang Pauli, stuck.

In that chapter I describe and perform my methodological innovation of 'the holographic' through a photo-essay that runs parallel to the audio-visual composition *A Borderline Conception.* Building up from Karen Barad's methods of diffraction (discussed in the next section: Key Concepts), I introduce and perform a *critical interferometry* of the Baikal neutrino telescope experiment to discuss the sites multitudes, its many overlapping layers, histories, elements, and forces that animate and multiply it, revealing its more-than, its *holographic*. After this performative formulation of my site, I introduce an analysis of my theoretical concerns, best understood through the camaraderie between two very different types of scientists each interested in what they termed, 'the psycho-physical problem' of the sciences of observation and the necessity for what they called 'a new conception of reality' - one that

would include the irrational with the tangible. It was during that research phase, in post-production, that I came to begin to understand my own practice in relationships to animism, Magic, and mysticism which allowed me to be more explicit about what cannot be captured by scientific lenses and methods. This was largely due to a reading of Federico Campagna's *Technic and Magic: The Reconstruction of Reality* (2019) that helped me better understand experiences I have had since a young boy in the forests and rivers of Turtle Island (settler Canada). I finish that first case-study chapter by reflecting and reiterating the artistic methods used to become sensitive to environments of ecological and cosmological origins, as well as the more general method of critical interferometry that 'the holographic' implies for art-science collaborations.

Each subsequent chapter takes this similar structure. A new work and case-study is introduced through a more performative reading and introduction, then an analysis of its theoretical or historical content or meta/physical concerns or implications are uncovered, then reflecting on the strategies of making and discovery that went into the work and the development of the holographic method that has been generative for producing new artworks, concepts, and perspectives. Just what *the holographic* is and can do is developed and described over the course of the written work and can be felt through the audio-visual material included. A mixture of story recounting fieldwork and theoretical engagement helps me share diverse experiences and affects that I have encountered while also eliciting what I have learned from them, the challenges I have faced, and the tools for working through them towards relevant and meaningful art-science collaboration.

The second chapter deals more explicitly with difficult collaborations – working with institutions or individuals who seem to have feelings of superiority around their epistemic practices thereby immobilizing relevant exchange. I focus on one particular case with communication officers that radically transformed projects I was working on, either ending them, or diverting them to other hosts and sites. What is remarkable is that some very interesting work still emerged from these challenges, and this second chapter takes as its starting point a performance lecture turned video installation that was produced with the support of a GeoHumanities Creative Commission from the Centre for GeoHumanities, Royal Holloway University of London. *Viriditas: In the Future Perfect* emerged from fieldwork at a number of experimental *fusion* (not fission) sites in the UK and Europe. In that 4th chapter I discuss the philosopher and mathematician Albert North Whitehead's influential term, *bifurcations of nature*, which I use throughout this thesis to describe the constructed dualities, the separations between nature/culture, mind/body, inside/outside, non/human and their influence in Western hierarchies.

While undergoing this research I also came across the concept of 'counterallegory' in the writing of Elizabeth DeLoughrey (2019) which I've since realized has become an essential tool in my methodological approach since 2016, and which I find in the work of many practicing artists today. With *Viriditas*, I began to confront more explicitly my own identity, privilege and position within structures of white supremacy and scientific cosmology. I also began to encounter and engage in a much wider breadth of critique, leading me towards an intersectional analytic that considers race, gender, and class, within feminist science studies and environmental humanities more thoroughly.

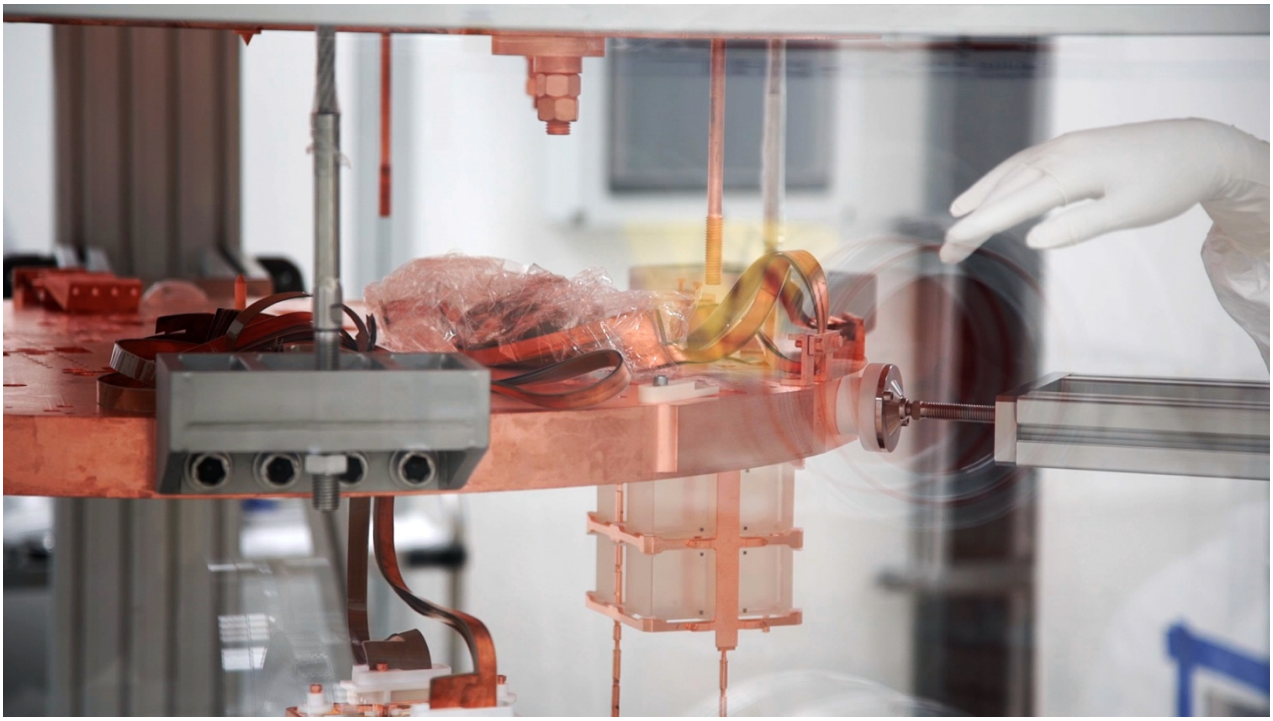
In 2016 I won the MERU Art*Science Award to produce a new video work at the Laboratori Nazionali del Gran Sasso (LNGS), a neutrino and dark matter lab that is 2km's underneath a mountain outside of Rome in the Abruzzo. It is there, though I didn't recognize it at the time, that I had begun to develop the concept of the holographic that is now explicit in my most recent research and exhibition currently touring in Canada, *n-Land: the holographic (principle)* (2021). As part of the *Drift: Art and Dark Matter* residency and exhibition project, I had the opportunity to visit SNOLAB, a 'class 2000' clean lab, 2kms underground within the Earth's second largest meteor impact basin. In 2015 SNOLAB director Art MacDonald shared a Nobel prize in physics for successfully describing a phenomena called 'neutrino oscillation' with Japanese collaborators. Without getting too much into the details of neutrinos and their oscillations right here, what might be helpful to know at this early stage, is that these 'oscillations' of neutrinos fundamentally challenge everything physics, up to this point, knows about particles. Like other famous quantum phenomena, these oscillations have meaningful ontological implications, rewilding what we know about reality and reiterating its fundamental indeterminacy. The 5th chapter discusses this new work, the methods and concerns developed to make critical holographic analyses of SNOlab. Essential to this project was the fact that it offered me, for the first time since I had left Canada a decade ago, the opportunity to consider my own identity as a white settler and to consider, from this context, what might be called 'settler science'. I was very concerned with how to make work in this settler context that could be a respectful anti-colonial engagement with the Land.

03. *G24|0vßß* by Jol Thoms. Installation view. "Blind Faith: Between the Visceral and the Cognitive in Contemporary Art" (2018) Haus der Kunst, Munich. Photo: Maximilian Geuter.[5]

[5] The audio-visual composition G24|0vßß (2016) can be viewed with the password: FERMIPARADOX at this link: https://vimeo.com/184221055

04. *G24|0vββ* by Jol Thoms. Detail view. “Blind Faith: Between the Visceral and the Cognitive in Contemporary Art” (2.3.-19.8.2018) Haus der Kunst, Munich. Photo: Maximilian Geuter.

05. *G24|0vßß* by Jol Thoms, 2016. HD, Colour, Stereo. Still Image



06. *G24|0vßß* by Jol Thoms, 2016. HD, Colour, Stereo. Still Image

It is quite rare in art-science collaborations to have long standing, respectful, and trusting collaborations, as that which I have developed with the SFB1258 leaders Elisa Resconi and Kilian Holzapfel after that fateful meeting atop 1.4kms of freshwater. As many artists working in science fields know, to approach and develop good collaborations requires trust and respect, a willingness to learn and unlearn – from both sides. Though completed in 2016, I mention the work G24|0vßß produced in Italy because it was included in a major European exhibition in 2018 during my study and initiated the trajectories I am still following. This work helps to reveal the deeper lineages of involvement and experience I have had within physics, its relationships to landscape and the more-than-human, and links to the workshops and fieldtrips I've led to the LNGS with physicist and artist students from Munich. Through these relationships, these workshops, and this research, I have also developed the multiyear sound art project *Radio Amnion: Sonic Transmissions of Care in Oceanic Space* which more explicitly and intentionally

crosses cosmologies of science and culture, commissioning and foregrounding queer and minority artists to send soundings and voicings directly in and to the Pacific Ocean. While *Radio Amnion* (2020-ongoing) is also discussed briefly in the conclusion, it gestures to possible futures of respectful anti-colonial art-science collaborations, collectives, and communities. All the theoretical work that I have been pursuing during my research period as a PhD candidate has led to this work which, after years of preparation, launched in June 2021, just as I am finalizing this thesis.

Throughout each of these case studies located within these landscape-laboratories, an emphasis on the 'natural' environment, the geologic media, *the elemental* is quite explicit. The embeddedness of technological apparatuses in Earth, in its materials and elements, its gases, liquids, solids, and plasmas, in its mountains, deserts, lakes and oceans is crucial in accounting for the eco-social work that this thesis develops, tracing important shifts and ruptures that the physics assemblages themselves, through their very existence, imply. I am suggesting that these sites deeply trouble and reformulate the metaphysical concepts of agency, nature, technology, and the category of the human. Operating beyond inherited and deeply flawed scientism of mechanical Cartesian logics I gesture towards more holistic, lively and 'animistic' meta/physics found in Indigenous philosophies, new materialisms, world religions and folk traditions. A simple question remains the same throughout: if these landscape-laboratories exist, what are their implications for western metaphysics? What are the meanings of their explicit reconfigurations of the world? "The point is that more is at stake than 'the results'", writes Barad (2007, p.391) gesturing beyond the measured phenomena of mere entanglement and intra-action towards the implications and contributions these phenomena have for what is

possible, for reconfiguring the theories of nature, culture, technology; knowledge, ethics, and being.

This dissertation is deeply indebted to 'agential realism' (Barad, 2007) and the 'quantum reformulation of ontology' (Thiele, 2014) found in the scholarship of many feminist science studies scholars: Vinciane Despret, Donna Haraway, Rosi Braidotti, and Vicky Kirby to name but a few. In much feminist scholarship, the 'politics of location' (Rich, 1984), and 'situated knowledge' (Haraway, 1988), is essential to overcoming the privilege of the 'partial perspective', the 'view from nowhere', that many disciplines perform in attempts to isolate otherwise entangled systems. In doing so these partial perspectives remove any responsibility between the scientific researcher, their knowledge, and its impact on the world. *Quantum Ecologies* proposes a 'view from somewhere' that leads to 'new knowing subjects;' (Braidotti, 2009), and an anti-colonial science that acknowledges and works to actively avoid onto-epistemic violence (Stengers, 2018), while remaining with the messy, troubling, complex material-discursive mangles that systems, objects, apparatuses, and subjects create and co-exist within and as.

07. *G24|0vßß* by Jol Thoms in the exhibition *Logics of Sense 1: Investigations* with Susan Schuppli, Michael Karikis, and Ursula Biemann, Blackwood Gallery, University of Toronto (2019).

Chapter 2: Setting Off: *Key Concepts, Contexts, Methods, Review*

08. *A Borderline Conception Lying at the Extreme Edge of the World of Appearances,* (Still), 2019. 3 channel HD a/v composition.

> "The inhuman nature of the artistic object consists of a combination of non-functionalism and ludic seductiveness… Art, not unlike critical philosophy, is … an intensive practice that aims at creating new ways of thinking, perceiving, and sensing Life's infinite possibilities. By transposing us beyond the confines of bound identities, art becomes necessarily inhuman in the sense of non-human in that it connects to the animal, the vegetable, earthly and planetary forces that surround us. Art is also, moreover, cosmic in its resonance and hence posthuman by structure, as it carries us to the limits of what our embodied selves can do or endure." (Braidotti, 2013, p.107)

2.1 *Ludic Seduction*

Knowing is a messy business. Describing what art is may be even messier, but philosopher of the posthuman Rosi Braidotti provides an exciting perspective on art's reformulative and regenerative cosmological capacities. There is a paradox in her description that suggests that playful 'non-functionality' can nonetheless carry seduced participants beyond traditions and limits, into new territories of knowing and being, of acting and comporting. In the case of Braidotti, and so many other science studies scholars we will encounter throughout this thesis, these 'new knowing subjects' (that can be any sort of entity) emerge through deeply ethical entanglements and concerns – what we know, how we know, and how we communicate these things (who we are) - how knowledge and its practices transform us, our relations and the worlds we inhabit, destroy and create, offers challenges to the pasts, presents and futures of life on planet Earth. There is no doubt that we who are living in the third decade of the 21st century are indeed living through a time of deep critical urgency. I am writing this in the middle of a global pandemic that has already taken more than 3 million lives globally while divisions between classes grow phenomenally wider; a world on fire, quite literally, as vast forests across the globe have succumbed to colonial logics, agribusinesses and land grabs; sea levels are rising faster than scientists worst scenarios due to runaway, unchecked industrial pollution, sanctioned by the corporate governments that profit from these destructive extractivist logics; permafrost melting, methane particles over 1900 parts per billion in the atmosphere; far-right science denial 'activists'; traditional ancestral land keepers and protectors are being murdered by the hundreds, at increasing rates every year for the last decade (Hodal, 2021; Greenfield &

Watts, 2020; Watts, 2018).[6] It seems unprecedented, the scale and complexity of these interrelated situations. In these troubling times, what roles do contemporary art and experimental theory have? What can experimental concepts, aesthetics, or positions do, and how?

The focus of this experimental practice-led investigation *Quantum Ecologies* employs sets of recurrent themes, contexts, practices and concepts that attend to some of the urgencies of our onto-epistemic conundrums. Scientific knowledges are varied and diverse, and some seem more urgently applicable and imperative in our time, and yet the histories of western scientific practice are problematic regarding their support of colonial and extractive expansions, exploitations, and expropriations. The now infamous work on the 'geophysics of race', Kathryn Yusoff's *A Billion Black Anthropocenes or None* (2019), for example, reveals embedded and extractive racism in the very emergence of the field of geology through an analysis of Lyell's complicit behaviours and explicit language.[7]

At a time when civilization is being explicitly restructured and the global climate is drastically and rapidly shifting and mutating, the sciences' particular expertise is eminently necessary and important, yet new fascist-corporate regimes have been undermining the work of and belief in sciences' efficacy. This has been ongoing for generations, in pursuit of anti-democratic destabilization and capital accumulation at the expense of living earthly landscapes,

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[6] On the documenting of murdered land defenders see also Global Witness: https://www.globalwitness.org/en/blog/ or https://theconversation.com/more-than-1-700-activists-have-been-killed-this-century-defending-the-environment-120352

[7] See the Special Issue of the geography journal Environment and Planning D: Society and Space dedicated to the 'Anthropocene as Colonial Discourse' (Simpson 2018). See also Davis & Todd 2017; Todd 2015; Whyte 2017)

bodies, and communities. We know that corporate actors have continually accelerated the toxicity of the planet, often times knowing full well of their actions' repercussions (Hall, 2015).

Scientific knowledge, the stories the discipline can tell about the world and reality, about ecology and Earth systems, and *the stories it tells about itself*, need to be extensively and critically (re)examined. Since artists, theorists, and poets alike are trained to be critical of society and culture, they are in a particularly crucial time and position to ethically contribute to these processes. In what follows I approach the sciences through their primordial foundations and outline a number of projects that I have developed in collaboration with various physics sites, sites that are embedded in ecologically protected zones, where vast, *weird* cosmological sensory assemblages are intimately entangled with natural elements; planetary bodies such as lakes, deserts, impact craters or mountains. One of my central arguments is that the very existence, the forms and hybrid structures of these ecotechnical sensory assemblages, *as well as their objects of study* – non-optical, uncharged, imperceptible yet omniscient subatomic particles – have considerable metaphysical implications concerning what white privileged westerners mean when referring to 'nature', 'reality', 'technology', and 'cosmos'. These meta/physical implications trouble, challenge and unsettle the ethics of knowing and being in the world, the 'scientific cosmology' of the west that has been abstractly disembodied from the world.

I consider this aesthetic practice that produces videos, scholarship, installations, workshops, and sculptures as 'experimental theory'. I am not merely working to produce artworks, but to also produce new conceptual tools for thinking about the matter and meaning of land, relations, liveliness, and experience. What is fundamental to my reflections,

refractions, interferences, and diffractions throughout this work, is the essential acknowledgement that the world, its many states, creatures, minerals, and forces, is *alive*, a communicative sentient holographic metaorganism. Being open to learning from and thinking with the entangled materials of the living Earth is what partially constitutes this projects' experimental spirit. For me the Earth has always operated far beyond mere human capacity to measure, understand, or perceive. Humans are like gut bacteria, living within and influencing, as well as being influenced by a larger complex quantum organism that is essentially impossible to fully know or understand. This impossibility does not mean that we aren't symbiotic, or sym*poeitic* (Haraway, 2016), but it does mean that we must learn to be humble and responsible to the host 'mothership' Earth.

If we are to believe the images of space and cosmos that astronomers and physical cosmologists have developed over the last few centuries are real, if we take those images of exoplanets and galaxies to be realistic and true to some extent, then we necessarily ought to understand that this fragile Earth is also a very rare, special, unique emergence, an attractor and multiplier of complex life, thought, dream, phenomena - for organized complex experience and communication. It is literally the only life-harboring planet known by its inhabitant species' in the vast ancient, cyclical cosmoses we call reality. It baffles to think that human/capitalists cannot treat the only known living planet as such.

Afrofuturist science fiction legend Octavia Butler diagnosed humanity, in her Xenogenesis Trilogy, or *Lilith's Brood* (2000) as genetically predisposed to self-annihilation due to hierarchical thought tendencies – that is genetically ingrained belief in hierarchies and the organization of society around those predisposed beliefs. What might fall under the category of

'hierarchical thought tendencies' might be global patriarchy, historical divisions between 'types', genders and races of humans, even distinguishing between what is alive or not, as Povinelli (2016) explores in *Geontologies.*

2.2 The Experimental Spirit

> "To use the world well, to be able to stop wasting it and our time in it, we need to relearn our being in it…What tools have we got to help us make that reach?" (LeGuin in Tsing et al. 2017, p. 15/16).

Without the stretch or the zoom, a fractal is not as beautiful or mesmerizing, not nearly as complex. As with fractality, moving towards an edge reveals there are still entire universes to be discovered - and, just as there are no clear centers, there are similarly few if any true edges. In my research multiplicities and iterations are generative of intensities and pluralities that continually lead me through colorful gardens of forking paths. Slowly, logics and methodologies of emergent stochastic patterns are revealed. Openness to the contingent materialities of research, allowing oneself to be lead, rather than to steer, is essential, and this is why setting methods from the outset is not helpful for this type of creative research. It is therefore necessary to reconsider from the outset the rigor that underpins the 'experimental spirit' that is often evident at the frontiers of new materialist artistic-research's possibilities:

> "If one is not immersed in, even overwhelmed by, the material, there is no creative experimentation. In the course of the interaction with the material with which one works in an experiment, the material itself somehow comes alive. It develops an agency that turns the interaction into a veritable two-way exchange. It's both a forming process and a process of being informed". (Rheinberger, 2013, p.198)

Historian of science H.J. Rheinberger here is writing about scientific experimentations and their similarities with artistic practices and methodologies. The *coming alive* that he mentions is what this research has also done over the course of four years - it's what the artworks and concepts emerging from it do and celebrate, because the worlds of matter and meaning that it observes and responds to is also alive, excessive, and thriving. In Rheinberger's efficient quote above, his *spirit*, is not necessarily referring to something effervescent or spiritual/religious per se, but rather an operation of keeping *materials* at the centre of our investigations, recognizing them as the true drivers of discovery and holders of innovation. This is the experimental spirit: learning from material engagements and drawing out, tracing, discovering the relations and boundaries they consistently (re)create, declare, impose, and shift. The experimental spirit can be considered the unmethod that drives both the theoretical as well as the practical necessity that underpins the essential intuition that operates in the fields of art and science. In practice this means, that while out onsite, with recording devices, I have not preplanned shots or actors, etc. There is an unplanned desire to *search* and be led by places, minerals, moments, creatures, and situations that allows for spontaneity, and adaptation to experiences. This in turn produces an excess of material that is led by the site.

In my 'landscape-laboratory' fieldwork, part of my materials are anarchic, imperceptible, subatomic particles: dark matter and neutrinos - who have become nonhuman collaborators in this practice. Other materials are remote environmentally protected landscapes, weathered by time, ever changing, and entirely communicative. Technologies of sense are embedded in these landscapes - in the elemental makeup of planetary bodies. Personal, philosophical, conceptual, critical, (un)disciplined stories and allegories coalesce through experiences, failures, videos, fieldtrips and a host of happy accidents. I have been overwhelmed by the materials and documents, pdf's and hard drives of audio visual material; overwhelmed by the changing world, this being written during the corona virus pandemic and the radical and long overdue social upheavals brought about by the death of George Flloyd in Minnesota in the summer of 2020. There is an overwhelming sense of urgency towards the state and health of the planet as a social, precarious creature, slowly consumed by human energy infrastructures and their power brokers inability or unwillingness to adapt to our unprecedented atmospheric situations. Rheinberger writes how, "the concept of experimental culture does not merge and is not coextensive with the classical notion of a discipline. On the contrary, experimental cultures constantly tend to shift, to displace, and to subvert the contours and confines of established disciplines" (1997, p.138). The notion of the experimental spirit discussed here is central to my practice alongside a set of key concepts that informs this dissertation which I unpack below.

2.3 Diffraction

The scientific understanding of diffraction comes from over a century of observing and theorizing light and atomic particles, trying to understand their fundamental constituents and behaviors. To diffract in this case, initially emerges from optical properties of energy interactions, particle-waves interfering with each other and themselves. These optical phenomena have allowed very powerful insights from otherwise imperceivable in/congruities of matter and energy. Diffraction patterns infamously led to a very important and challenging discovery about fundamental properties of atomic and subatomic particles – that they can be either wave like or particle like depending on how one observes them. For centuries before this discovery natural philosophers argued for one or the other. With quantum physics we can hold the compossibility that matter is not fixed, but statistical, multiple and dynamic while also being in a place and time. These discoveries inaugurated the 20th century with a radical rupture that has not to this day been fully realized by society or culture: the fundamental *indeterminacy* of matter at the micro scale. When matter interferes with itself at the quantum scale, diffraction patterns emerge. In the oft noted 'double slit experiment' electrons have been revealed to be both particles and waves (depending on how one observes them), a condition that is still often considered incommensurable, or paradoxical. The intra-active patterns that emerge from these experiments are what become signals of interference and interaction, and which can be read in a number of ways for determining past and future events and for understanding manipulable properties of energy. Throughout this and the next chapter we will return to diffraction to understand it in different contexts.

The *theoretical* methodology of diffraction was developed by Karen Barad in *Meeting the Universe Halfway: quantum mechanics and the entanglement of matter and meaning* (2007) and has gone on to have quite a life of its own, inspiring literature and cultural studies, as well as hosts of students across many creative disciplines (See the Special issue on diffraction in the Parallax Journal 2014, the Performance Research Studies Journal 2020, or the *Diffractive Reading* publication edited by Kai Merten, 2021). Diffraction was initially introduced by Donna Haraway in her paper *The Promises of Monsters: A Regenerative Politics for Inappropriate/d Others* (1992) as a non-representational counter-optical metaphor for thought, in place of, or alongside the metaphor of *reflection.*

Reflection as a dominant way of thinking and self-contemplation has epistemological challenges due to its 'doubling' and its holding at a distance. Barad writes, "Reflexivity, like reflection, still holds the world at a distance" (2007, p.87) which feeds into issues of the 'view from nowhere' or theorizing from 'nowhere'. According to Haraway's analysis the geometry of the optical phenomenon of reflection develops this presumed distance from the object of inquiry and produces only a two-dimensional copy as in mirroring. A different optical metaphor for thought, suggested Haraway, is diffraction, while thinking with the work and practice of the Vietnamese feminist filmmaker and theorist Trinh Minhha's 'inappropriate/d others' (1989) which is the mode of being, 'in critical, deconstructive relationality, in a diffracting rather than reflecting (ratio)nality – as the means of making potent connections that exceeds domination" (1992, p.299).

Desiring a way for the social sciences to become a model for the natural sciences, Barad writes about her diffractive methodology,

> "[M]y method is to engage aspects of each in dynamic relationality to the other, being attentive to the iterative production of boundaries, the material-discursive nature of boundary-drawing practices, the constitutive exclusions that are enacted, and questions of accountability and responsibility for the reconfiguring's of which we are a part. That is, the diffractive methodology that I use in thinking insights from different disciplines (and interdisciplinary approaches) through one another is attentive to the relational ontology that is at the core of agential realism. It does not take the boundaries of any of the objects or subjects of these studies for granted but rather investigates the material-discursive boundary making practices that produce "objects" and "subjects" and other differences out of, and in terms of, a changing relationality" (2007, p.93)

Diffraction is a method that thinks and reads disparate and agentially separate entities (disciplines, insights, objects/subjects/phenomena, times, and places) through one another for the purposes of developing new forms of critique and perspective, and crucially for attending to the boundary forming processes that produce those very forms. Diffraction is intentionally generative of interferences that produce differential patterns that would otherwise be impossible to perceive.[8] Crucially non-representational, diffraction casts itself as, "a performative account insist[ing] on understanding thinking, theorizing, observing as practices of engagement with, and as a part of, the world in which we have our being," and perhaps

[8] My Anthropocene Review article *Intra-acting with the IceCube Neutrino Observatory*, co-authored with Sasha Engelmann (2017), is an example of this diffractive multidisciplinary method in written form. It reads and criticizes a concept of an earth scientist – the 'technosphere' (Haff, 2012, 2014a/b) concept – through a vast experimental assemblage - the IceCube Neutrino Observatory – and the entity of its search, its 'epistemic thing', the ever-anomalous subatomic neutrino.

most interesting for art practices, "precisely a contestation of the excessive power granted to language to determine what is real." (Ibid. p.133)

Diffractions transdisciplinary approach rooted in physics-philosophy is specific to my research investigations overall, its alternative modalities of what, "enables a critical rethinking of science and the social in their relationality" (Ibid. p.93). This critical (re)thinking will help us to contribute to the question of the science's articulation in broader society and help to articulate the value of difference and multiplicity.

Taking diffraction slightly further into realms of critical place inquiries, though remaining in the field of quantum theory and physics-philosophy, I have developed a metamodel for analysing and experiencing the plural overlays, positions, possibilities, and perspectives that are apparent at any site. Based on the confirmation from my research, and experience in the field – which is to say at specific and particular places - my assertion is that the *holographic* metamodel that my thesis develops is generative of data, evidence, and experiences that are otherwise imperceptible, revealing hidden connections and relations across time, space, matter, and meaning.

The critical interferometry of the holographic was partially developed by reading Barad's method of diffraction through Rheinberger's 'experimental spirit' and 'experimental systems' – "vehicles for materialising questions" and "making the future" (Rheinberger, 1997, p.28). I've simultaneously brought their distinct yet reinforcing concepts back in/to physics laboratories, phenomena, and landscapes to test and challenge them. Rheinberger noted similarities within his own explication of an 'experimental system' with that of Levi Strauss's 'bricolage' method (Rheinberger, 2013, p.201). The metamodel of the holographics *diffractive*

system critically reads the interference patterns of sites, their many practices, histories, and forces, and attends to their projective and emergent features, to their overlaying multiplicities in what I'm referring to as their *holographic*. Critical Interferometry transcodes passing matter(s) and meaning(s) through one another for articulating hybridity patterns emerging from geosemiotic laboratory-landscapes. There is an active performativity (rather than representation) that I seek out in these sites and assemblages, a sensibility that evades common measure. Although Interferometry implies measurement, we can take it in this case to be especially qualitative in its approach. Applying plurality and multiplicity to every site and situation, not shying away from the excess of any place, in fact it unearths through those densities precisely what is incommensurable with classical western meta/physics.

"In using a diffractive methodology, one is attentive to fine details of different disciplinary approaches," (Barad, 2007, p.93) it is true, but in my own contemporary artistic production and my experimental theory, excess, density and iteration is also helpful, meaningful, and generative. Since diffraction, 'attends to specific material entanglements', as 'a way of understanding the world *from within and as a part of it,*' (Ibid, p.88. my emphasis) it remains to me an invaluable starting point for engaging and attending to the multiple 'characters', entities, materials, concepts and fields of science that my practice engages in. A renewed emphasis on location and situatedness resonates with the Anthropocenic need for humans to decenter and reconsider themselves *within* the fragile 'critical zone' of life along the thin surface of Earth.

Within feminist science studies, a critique of the 'view from nowhere', the idealized 'gods eye view' that so many scientific practices and disciplines perform through necessary but

fabricated removals is simply no longer a tenable practice to know from. The world is so intensely entangled and distributed, where practices of knowing are now more widely understood as always already indicating ethical and cultural paradigms, already having certain relations to power and privilege. As Haraway mentions in her essay *Situated Knowledges*: *The science question in feminism and the privilege of partial perspective* (1984), these separated views from nowhere are power moves, as "everywhere and nowhere means non-locatable and free from association and interpretation", which make these simplified smooth knowledge claims, "unable to be called into account" (Haraway 2004). To consider that knowledge, its keepers, producers, as well as its communication, comes with complex layers of responsibility that must be accounted for and is an essential theoretical focus of my thesis. An inability for critical interaction within the epistemic practices that measure and define the world in strict and eliminative ways means that actually attending to western onto-epistemic practice as another cosmology rather than a universal reality to which everything else must be measured, can begin to shift.

Interacting with science from the humanities and social sciences was for a very long time nearly unthinkable. Bruno Latour's *Laboratory Life* (1979), and the early sociological and anthropological research of Lucy Suchman, for example at the Palo Alto Xerox research labs, began to open up these fields to legitimate scrutiny in the 1980's. What this means for Haraway and her many followers - embedding scientific thought and action back through their cultural, historical, economic or political situations, through the perspective of the social sciences, reinserting them back into the world, is "the only way to find a larger vision… to be somewhere in particular" (Haraway, 1988, p.590).

In my artworks I am deeply interested in an ecological thought, or an *ecosophical* (Guattari, 1989) project – a rethinking of elements, environments, times, agents, spaces, places and their socially constructed boundaries – and so this radical account of agential realism that disavows ontological separation of objects into discrete entities in favor of agential *differentiations*, presupposes the world(s) as an integral body. The many-worlds of Earth and its vibrant multiplicities embrace and differentiate, but are not separate. The imposing of divisions between worlds and their materials, beings, and cultures is understood as a form of violence often enacted for the sake of imposing hierarchies - extracting and exploiting. It is true that boundaries are necessary for distinguishing, communicating, constructing worlds of knowledge and ethics, but those boundaries are relative, contingent, and ultimately porous, mutative possibilities – they are enacted. Barad points out that boundaries are only between forms of agency, not things themselves. The processes of *boundary making,* they insist is the locus and site of any of our knowledge, objects or subjects. The very condition of knowledges possibility is wrapped up in material(s), irremovable from the stuff of the world(s) and their cosmoses. The attempt at placing knowledge outside of the world or removed from matter(s) will not suffice to think the (techno)ecological condition and epoch that the 21st century is faced with.

What an agential realist, entangled perspective offers to thinking an apparatus is of quite significant relevance for critiques emerging in feminist science studies and for this dissertation. In my practice I collaborate with subatomic particles and physics laboratories where entirely new forms of observation, and entirely new types of apparatuses, or 'experimental systems' are designed, built, and used to interpolate new knowledge about nature. These new arrangements of technical sensors necessarily embedded in the elements of

planetary bodies perform the systematic entanglements Barad and Rheinberger present to us when they discuss the apparatus and experimental systems. We might consider these new experimental apparati as 'enunciative assemblages' (Guattari 2012), complex arrangements of agents, elements, and techniques announcing a new order of vision and communication with nature and reality, pointing to the possibility of a renewed meta/physics that I propose we can collect for poetic, aesthetic and socio-cultural reterritorializations. Ironically, the physical sciences themselves, having had been lured by some anomalous entity or imperceptible event, some 'epistemic thing', eventually reveals the untenable structures within the philosophies underpinning their own practices. Once held truths and methods for practice and description, have become suddenly opened, lifting the corner of power so that we can peel back the veneer.

2.4 Experimental Systems; Epistemic Things: Neutrino Weirdness

The new order of 'experimental systems' my research investigates can be considered as 'cognitive instigators', forces for thought that help us to think and question traditional limits. "Indeed, experimental systems are arrangements that allow us to create cognitive, spatiotemporal singularities. They allow us to produce, in a regular manner, unprecedented events" writes Rheinberger (1997, p.23). "They are not merely devices for generating answers," he continues, "they are vehicles for materializing questions" (Ibid, p.28). Rheinberger discusses the condition under which new knowledge is formed in scientific laboratories, with an emphasis on experimentation with 'epistemic things' – "halfway-concepts" & "not-yet-values and standards" based on vague characteristics of what one does not yet know (Ibid. pp.28, 36).

The experimental systems of my fieldwork, the holographic landscape-laboratories and the epistemic things of neutrino particles produce extraordinary events partly because they cannot be detached form the matter(s) within which they are embedded: ice shelfs, mountains, lakes, atmospheres, deserts. The distance between technology and nature has explicitly collapsed at these sites troubling and recreating differences and differentiations. Elemental planetary bodies are the very stuff of the 'detector'. Neutrinos also engage in unprecedented events because they operate on the edges of known physics and human sense perceptions. These objects of investigation are not yet known or understood, or, at least, accurately measured. The neutrino does not fully reveal itself: it 'lures' (Stengers, 2000) scientists to discover new information about the nature of spacetimematter, and in doing so challenges the ontology of scientific cosmology. Neutrinos are not charged matter like all other matter we weigh and observe. Also, while all other matter in quantum systems have a 'wave function collapse', meaning they move from a 'superposition' of being anything whatsoever to a clearly defined something with charge and mass when observed, neutrinos 'oscillate' between three masses, never fully collapsing - so to speak - into one or another entity, shifting between tau, electron, and muon neutrino effortlessly, even after it has been recorded.

"The reality of epistemic things lies in their resistance, their capacity to turn around the (im)precisions of our foresight and understanding", writes Rheinberger (1997, p.23). Science's own materials reveal and challenge the myth of human exceptionalism in the construction of knowledge: the supposed ability to detach and sever from the world and take an objective view on it; the myth of the lone genius, untangling the mysteries of nature, cannot be defended with the new practices of experiment I am engaging with. In an interview I conducted with Dr.

Francis Halzen, the director of a vast experimental apparatus, a neutrino detector embedded within the depths of a 200,000-year-old ice shelf, Halzen proclaimed of the construction and placement of the cubic km *IceCube Neutrino Observatory* at the geographic south pole, “We had no choice, nature built the detector for us” (Thomson and Engelmann, 2017).

By moving towards accounts of ‘performative’, ‘felt’ and ‘situated’ knowledges my artworks engage in the wider spectrum of entangled planetary and cosmogenic materials, the objects and entities that are part of a posthuman assemblage of elements, sensors, and places. My works do not work in a didactic way that some may prefer, but rather they engage through poetics, gestures, diversions, deferrals, tempos, displacements. I think of my audio-visual compositions as poems on meta/physics, where forms found in cut, color, and duration express a code that cannot otherwise be expressed, where openness to the sites, or to whatever might emerge in the research - and following those leads - often develops into trajectories and patterns I could not have foreseen or known from the outset. Therefore I do not have a specific method, but a sensitivity, an experimental spirit that I bring to materials and sites.

A mode of accounting and attending through care and sensitivity lies at the heart of my artistic practice: it allows me to ask new questions that in turn animate and shift my artistic production. By accounting for the wider material culture of the locations where new knowledge is formed, I get a broader understanding of the systems ecology that knowledge emerges from with/in. Through this process of attentiveness to what was once considered, at best, peripheral we learn to account for relations across the material-discursive boundaries of practice where new developments in epistemological paradigms fluctuate. A host of new objects for thought begin to emerge.

Rheinberger's linking of scientific research with artistic production has been well received by artistic-researchers (Schwab, 2013; Dobiey and Helmert, 2015). This is particularly interesting for this project which proposes a novel methodology for interdisciplinary creative practices and is what sets his work apart from Barad's. One interviewer describes Rheinberger's experimental system, "as reminiscent of a playground of coincidences, or more so, a system to achieve serendipity, which neither provides the end result, nor suggests a defined route" (Dobiey and Helmert, 2015). Significantly, the work and lives of artists have always had a sort of communicative relationship with materials or the 'machinic unconscious' (Guattari, 2010), and have so often heard and responded to the intentions and desires of the stone, the paint, the canvas, the landscape, the dream. In *Experimental systems: future knowledge in artistic research*, Suzanne Witzgall (2013) writes about the 'co-participation guided by the material' in the work of Karla Black and in relation to *things*. In an interview with Black from 2007, she reveals, "The things themselves are actual physical explorations into thinking, feeling, communicating and relating. They are parts of an ongoing learning, or search for understanding, through a material experience that has been prioritised over language" (p.45).

This priority over language is significant when we're working in creative-research and practice-led modes. It becomes apparent and clear that there are other modes where language does not suffice. This may be one of the key reasons artists become artists, because they have other capacities for arranging matter to communicate differently, if not strangely. In my creative practice as a 'para-ethnography' I reveal a concern for the necessity of extending boundaries of agency and causality outside the sphere of the human; to do the ethical work of 'accounting for more of the apparatus' (Barad, 2007) that might lead to better descriptions of

scientific methodology, and that might help us to better understand novel avenues for creating new knowledge and relating with others.[9]

The choreographer Isadora Duncan's phrase often comes to mind during this process: "If I could say it, I wouldn't dance it".

2.5 Landscape-Laboratories

My research is dealing with a specific contraption or 'assemblage'[10] (Deleuze & Guattari, 1988) that is referred to as a 'landscape-laboratory' (Beek, 2009; Leitgeb, 2017; Felsch, 2006). The Landscape-Laboratory (as I work with it) refers to physics laboratories that are embedded in environmentally protected landscapes or in an environmental concern, such as clean, renewable energy. The 'landscape' is a specific place with, like any assemblage, myriad histories, agents, and actors in complex arrangements. The chimerical Landscape-Laboratory challenges simple technological and natural boundaries of sense and as such might be considered as an 'enunciative' assemblage (Guattari, 2012) contributing to the articulations of the 'quantum reformulation of ontology' (Thiele, 2014); '*general ecology'* (Hörl, 2017); and 'renewed perception' (Guattari, 1989; Gomez-Barris, 2017; Ross, 2018). Landscape-Laboratories are particular arrangements of technical, theoretical, bio-geological apparatuses

[9] Although I first heard the term 'para-ethnography' from Holmes and Marcus (2006), I do not use it in the same meaning, but here I use it as an ethnography of the non-human: spending time with materials, landscapes, elements: learning from and listening to them.

[10] Deleuze & Guattari develop the theoretical apparatus of 'assemblage' (*agencement*) in *A Thousand Plateau's* to speak about the complex logics of their own philosophy as well as to describe specific arrangements of multiplicities and relations within and/or as structures or concepts. It is used specifically to analyse and describe events or phenomena, or in this case a site. Assemblage can naively be considered similarly to bricolage or collage, but can be further understood in terms of the relations any assemblage depends on and be considered as a complex arrangement of elements that are both and neither parts or wholes. For further analysis of the term please see: Nial, 2017; Dewsbury, 2011; Marcus & Saka, 2006.

and practices that embody and collaborate with/in vast planetary figures and diverse temporalities through the physical instrumentation of sensor arrays. The sensors must not be technical in a traditional way as we will see, but it is important to note that what is being sensed is some aspect of the environment, from micro, through local, to cosmological. In so doing these land-labs can help us to reflect on issues addressing the 'planetary commons' (Triscott, 2017).

A laboratory in the historical sense was meant to be a place removed from the wildness of nature: hewn, cleaved out of the noise, dirt and grit of the universe. A space, clean and *pure*, without the vagaries of existence, where clear, precise, *truths* can be discovered and described. The laboratory was meant to be the technology with which one could remove oneself, for a removed viewpoint, a 'gods eye view'. "Though consistently attracted to leakage from the presumed outside, the lab must evacuate "Nature" from its premises. Nature, which has played such a preeminent role in scientific history and thought, must henceforth be held at bay, and critically calmed from raging through the scientific work site. Nature cannot serve as reference for the experimental system, at least not in an unrestrained way." (Ronell, A. 2005, p.48) The new category of landscape-laboratory troubles all of this. It is a mode of description of an ecology of practices and agents which make up a form of 21st century experimental multidisciplinary investigation. To think with Hans-Jörg Rheinberger, the landscape-laboratory can be thought of as an experimental system that offers a vision of change, a challenge to thought and experience, and so defies a simplistic reading or description, itself becoming in the history of science like an epistemic-thing, something to think with and challenge our conceptions, leading to a different mode of thought. As an 'enunciative assemblage', the

landscape-laboratory as a site, structure, and entanglement *itself* announces something new, different or novel that will have repercussions for thought and ontological categories generally.

For the 'landscape-laboratory' of my quasi-ethnographic research this extension of *what counts* within the apparatus, or experimental system, leads to a posthumanist account of knowledge production and opens the possibility of recognizing that knowledge is always iteratively produced by humans and nonhumans in concert.

The landscape-laboratory can be considered a relatively new emergence in the history of science. Key to the landscape-laboratory is the realization that what the two terms signify are entangled, and that while they may have previously mutually differentiated one another, the terms, thought in a continuum and produced in practice, offer us a novel interpretation and perspective on scientific investigations. In a posthumanist account, a 'nature-culture continuum' (Braidotti, 2014; Haraway, 2003; de Castro, 2004) emerges as a non-dualistic understanding of *material-discursive* intra-action, "which stresses the self-organizing (or auto-poietic) force of living matter. Where the boundaries between the categories of nature and culture have been displaced and to a large extent blurred by the effects of scientific and technological advances" (Braidotti, 2014, p.3). The term and phenomena of the landscape-laboratory therefore perform within this mode of 'continuum thinking', and itself announces a novelty in the world, a shifting and bending of boundaries and exclusions. This further troubles the distinctions between technology and nature, and helps to think a new thought about them, to think with/in the *continuum* of technoecology (Hörl, 2013 & 2017).[11]

[11] Other 'continuum' thoughts and neologisms emerging from quantum physics and new ecological paradigms will be discussed later. It is what these words attempt to signify that my artwork presents.

> "Apparatuses are neither neutral probes of the natural world nor social structures that deterministically impose some particular outcome. Significantly, in an agential realist account, the notion of an apparatus is not premised on inherent divisions between the social and the scientific, the human and the nonhuman, nature and culture. *Apparatuses are the practices through which these divisions are constituted.* This formulation makes it possible to perform a genealogical accounting of the material-discursive practices by which these important distinctions are made" (Barad, 2007, P.169, my emphasis).

Crucially - and speculatively - consider the following: Italian Nobel prize winning physicist, Carlo Rubbia once said of detectors, "Detectors…are really the way you express yourself. To say somehow what you have in your guts. In the case of painters, it's painting. In the case of sculptors, it's sculpture. In the case of experimental physicists, it's detectors. *The detector is the image of the guy who designed it*." (Taubes, 1986, p.44, my emphasis). I would argue along with Barad and Rheinberger that the designing goes both ways: "Our instruments think with us…" (Peters, 2003). But what does all of this lead to if the detector is an ice shelf or a lake and the body of an experimentalist or collaboration? What implications are not yet tangible for bodies and embodiments and the becoming planetary of both machine and animal which the terms *technosphere* and Anthropocene have announced? Is the becoming-planetary body of technologies of sense, or the 'becoming environmental of computation' (Gabrys, 2016) also a reorienting and reimagining of the 'technical animal' (Stiegler, 1994) as enmeshed within the biotic and abiotic energies and forces of the planetary-cosmic? And how can this be

expressed without recourse to old iconography, what communications are necessary to transmit this abstract information, this de-subjectivization? It is to these questions of shift and transformation on these sites of landscape-laboratories that my work also is addressed.

The contextual apparatus of a Landscape-Laboratory already implies the breaking of the boundaries implied by either of its terms considered in isolation. This somewhat paradoxical situation challenges the ontological status of these entrenched and once rigid categories. The Landscape-Laboratory opens briefly onto what I have already referred to as 'continuum thinking'. Continuum thinking is emerging out of the disciplinary spectrum, out of the ecologies of practices concerned with *un*thinking the divisory - modernity's historical project of separation. It strives to reformulate some basic concepts of the world as relationally entangled complexes, as complementarities, as wholes. With Erin Manning, we might ask, between the *land* and the *lab*, "[i]n what ways does the hyphen make operational interstitial modes of existence?" (2016, p.11).

I think this *continuum* category of assemblage as a higher order pattern emerging through interdisciplinary practices of research-creation, nature-cultures, doing-knowing, making-knowing, material-discursiveness, and still other articulations that embody mutually exclusive categories that are no longer considered exclusive. The field of quantum physics itself may have initiated some of the greatest, or at least strangest onto-paradoxes in human history. Here I am thinking of complementarity, indeterminacy, and the 'wave-function'.[12] I want these

[12] These terms gesture to 'seismic shifts' in western understandings of matter, energy, force and the ontological status of nature, or 'reality' and what can be known. In the recent 'Realism Materialism Art' (Cox, C. ed) Elie Ayache wrote succinctly of *the wave function*: "the wave function… articulates whole ranges of possibilities that are incompatible with one another". *Complementarity* is a term that links to that incompatibility , or overcoming the status of incompatible, where mutually exclusive phenomena or objects are held together as compliments of one

continuums to be reproducible in aesthetics, in artworks, I want them to be felt and situated, and for those experiences to embark on slow, minor transformations. This is only possible abstractly, through audio-visuality as performance, as ensemble, as composition. I want those transformations to be generated out of this transdisciplinary methodology. I want their patterns to become explicit. The optical phenomena of diffraction have already led to the recognition of quantum paradoxes mentioned above, but what others can emerge to help us think ecologically, to help us think relationally, to think towards equilibrium, to know-live the continuum?

2.6 The Holographic

The methodological innovation of this thesis, its main contribution, is the concept and model of the holographic for critical creative place inquiry. It is influenced 1. by the object-phenomena of a hologram, 2. the multidimensional meaning of holographic from the physical cosmology of black holes, and 3. various non/Indigenous uses of the holographic as a metaphor in cultural anthropology. In a sense it can be considered as an 'interscalar vehicle' (Hecht, 2016) that allows us to read, feel, observe, and entangle with multiplre agents, places, times, stories, and scales of a site. Holographic Theory is an emergent theory from physics that is beginning to seep into many other domains as a useful tool for thought, perhaps especially in terms of ecological relationships. This thesis develops the concept of the holographic,

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another without ontological separation, ie: the particle-wave. In this thesis it can be a tool for reconnecting mind-body, nature-culture, internal-external, etc. *Indeterminacy* refers to both of these terms, but speaks to the fact that in quantum systems it is not possible to know all possible information, such as spin, charge, velocity, time, etc. One can only know these statistically due to the nature of observation, apparatus, and matter-energy.

performing it and elaborating on it as an analytical method for creative 'site-reading', or what I call 'transcoding' landscape-laboratories.[13]

Quantum holographic theory was developed in 1946 by Denis Gabor and independently in the study of black holes in the 1990's by Gerard 't Hooft (Hooft, 1993). Holography as a new scientific object emerged in 1964 through experiments using lasers to produce images, images that appeared to be 3 dimensional rather than flat. At the time, of course, many artists were interested and also experimenting with this new technology, for example Michael Snow, Louise Bourgeois, Margaret Benyon, and Dieter Jung. This idea of a hologram as an image, however, is only one aspect of holography which feeds into the larger metamodel of the holographic which I am developing through this thesis. What is salient at the moment is the method or practice of intra-dimensional projecting (flattening or expanding through dimensions / that multiple dimensions can exist *within* and simultaneously *beyond* the upper limits of a particular dimensions boundaries – in the case of a hologram, rendering a 3-dimensional object onto a two dimensional data-surface so it appears 3 dimensional on that surface).[14]

In *Holographic Epistemology: Native Common Sense*, by Manulani Aluli Meyer (2013) a very succinct description of 'a hologram' is sourced from Michael Talbots' *The Holographic Universe* (1991):

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[13] I have become aware of Jane Rendell's architectural theory-practice of site-writing, which similarly approaches the multidimensional and multi-perspectival possibilities of any site, landscape, or space. Also founded from the radical feminist architecture co-operative Matrix whose practice was developed in response to the hetero-patriarchal hegemony in the discipline of architecture. See: Rendell, J. (2002). *The pursuit of pleasure: gender, space & architecture in Regency London*. Bloomsbury Publishing. And: Rendell, J. (2007) Site-writing: enigma and embellishment. In *Critical Architecture* (pp. 170-182). Routledge.

[14] Later we will encounter intra-dimensional projecting to and from 7 and 11 dimensions through 4D spacetime.

> "A hologram is a three- dimensional photograph made with the aid of a laser. To make a hologram, the object to be photographed is first bathed in the light of a laser beam. Then a second laser beam is bounced off the reflected light of the first and the resulting interference pattern (the area where the two laser beams commingle) is captured on film. When the film is developed, it looks like a meaningless swirl of light and dark lines. But as soon as the developed film is illuminated by another laser beam, a three-dimensional image of the original object appears. The three-dimensionality of such images is not the only remarkable characteristic of holograms. If a hologram of a rose is cut in half and then illuminated by a laser, each half will still be found to contain the entire image of the rose. Indeed, even if the halves are divided again, each snippet of film will always be found to contain a smaller but intact version of the original image. Unlike normal photographs, *every part of a hologram contains all the information possessed by the whole."* (p.14)

Sometimes referred to as *fractal holography* the implication worth reiterating here, and what was revolutionary in anthropology as a critical situating, was the notion of self-scaling and self-similarity, allowing for self-reflection by the anthropologists of their self-similar position to that of their observational object (Wagner, 1991; Strathern, 1991). Mosko (2010) also writes that, "holography offers (to anthropologists) a new perspective from which phenomena perceived to be unrelated or existing at different scales might be connected" (p.152 ellipses added). According to Sweeney Windchief (2020) Manulali Meyer's *holographic epistemology*, refers to 'Indigenous common sense', where "the physical, mental, and spiritual components of

our being are not only intertwined, but *inform* each other and *interact*…. critically rethinking knowledge, science, and reality… because Indigenous peoples tend to understand this link as common sense and that these three constitute a hologram whereby *each is part of the whole, and the whole is in each part'* (p.53 emphasis in original). Meyer refers to 'the triangulation of meaning', "shaped by the needs of place and people" (Meyer, 2013, p.96). In terms of the holography of a landscape-laboratory, we could refer to the bio-geo semiosis of a site, the knowing and explication of and by nature to itself [The human here understood within and of nature – as nature (but a singular form in the infinity of forms of possible being in the cosmos)]. The added dimension of spirit to the assemblage of a holographic is an iterative processual openness to the intelligence and wisdom of Land. It is this recognition of sentience beyond and below (and not necessarily *for*) the human that materials and places have and exhibit] renders them holographic in this sense. The holographic reinserts 'natures queer performativity' into our analyses, (to borrow from a title of Barad) the dimensions of reciprocity and responsibility to places.

In physical cosmology the 'holographic principle' refers to the multidimensionality (4+n dimensions) of spacetime (where *n* denotes any number whatsoever). This has been made apparent by scientists quests to unify all known particles and forces into one coherent theory of everything, or 'grand unified theory' which string theory is an example of. Although no such coherent theory yet exists, or has been confirmed, physicists believe it should be possible to write an equation that expresses all the physical fundamentals of our perceived reality. In all attempts to produce mathematical proofs of a unified theory of force, where electromagnetism, the strong and weak nuclear forces, and gravity can all be described within

the same equation, physicists must add dimensions to their calculations. It is only by adding dimensions to the realities that their mathematics describes that the forces and particles can begin to cohere in any understandable way. In string and m-theory, expressions of the standard model of particle physics (ie. quantum filed theory) there are at least 10 and 11 dimensions respectively – in other theories there are really any number of dimensions possible - 26? Sure – why not? Quantum field theory itself suggests infinite dimensions. But this piling on of dimensions multiplies space by orders of magnitude with each additional dimension – physicists refer to the 'bulk' volume that these dimensions hold, and assume that many secrets and energies, new types of physics and properties reside within those places, within that *bulk*.

Projecting up and down through dimensions to make or describe or measure relations is what I found particularly insightful for thinking about place. By adding, or rather, *revealing* more dimensions of place we can begin to perceive connections between previously considered distinct phenomena, practices, or beings. Elaborating dimensions of a site, their various situations and/or histories, its elements and materials, its myths and spirits, allows for a more thorough understanding of a place and it's nature. By understanding a place better, we can better attend to it. In the context of a scientific landscape, this becomes an essential situating practice. It works to reveal "science and the social in their relationality" (Barad, 2007) while using scientific theories to iteratively do so. Working with scientific theories to operate on western scientific cosmology is another iterative approach to remaining meaningful to the disciplines in which I am working.

The holography of a landscape-laboratory then is a more *whole* encounter-with and understanding of the planetary body that it is technologically embedded in. Holography does

not assume or pretend to account for the 'whole' of any place or site. It is not a universal. It is merely an adding of dimensions of concern, a scaling up and down simultaneously for relevant interferences and connections. As an analytic tool it is diffractive, reading various disciplinary scholarship of sites through one another. As a method or practice it is spirited in its experimentality – its openness, intuition, and awareness of the more-than of a site or situation. Holography is also ecosophical in its plurality and commitment to responsibility – it is not only about creation or methods but about understanding and recognizing values. Holography of place refers then to the excessive potential of it, but what it points to remains non-conformable to a scientific measure. Author Michael Talbot (1991) writes,

> "Holography possesses a fantastic capacity for information storage. By changing the angle by which the two lasers strike a piece of photographic film, it is possible to record many different images on the same surface. Any image thus recorded can be retrieved simply by illuminating the film with a laser beam possessing the same angle as the original two beams. (21)" (quoted in Wagner, 2017, p 52).

A holographic reality is therefore incomparable, meaning completely, in its infinitude, non-representable. There are so many agents and angles of overlapping yet distinct perspectives. We are unable to represent holographic reality, though we can work with it as "a technology for turning a worldview into a world" (Wagner, 2017, p 52). The rest of this thesis attempts to expose the holographic metamodel through different case studies at various physics sites and in particular scholarship that address issues of 'holism', 'continuum thinking',

and lack of diverse representation in physics. In the following chapter, I perform the holographic metamodel through a transcoded photo-essay, while in the 4th chapter a holographic analysis reveals critical issues within the domains of physics while resituating it within its genealogical emergence from animistic tendencies in alchemy and natural philosophy. The final case study takes the holographic as its name, in a more thorough practice of the concept through installation in *n-Land: the holographic (principle)* (2021) – part of a touring exhibition and residency project in Canada.

2.7 Re/View from Somewhere

> "Disembodied assumptions and expectations can muddle our efforts to see things as they really are. Lack of self-knowledge about the reciprocity that exists between ourselves and the world in which we are situated leads to nature keeping its secrets when we most need to let the book of Nature speak for itself. (Kawagley, 1995, p.4)

"The detour by way of the outside," writes Latour, "introduced into the notion of 'nature' [is] a confusion from which we have still not been extricated" (Latour, 2018, p.68). In the recent exhibition project *Critical Zones: Observatories for Earthly Politics* (2020), organized by Latour, Peter Weibel, Martin Guinard, and Bettina Korintenberg at the ZKM Centre for Art and Media, Karlsruhe, the 'view from nowhere' is often criticized, for example by the Taiwanese artist Yu Hsin Su who has written in the exhibitions *Fieldbook* in regard to their 2 channel video installation *Frames of Reference* that emerged from investigations of landslide sensing

technology and data, that, “With the disappearance of the metaphysical Globe, I am interested in the shift from ‘the view from everywhere and nowhere’, to the ‘view from within’, and examine the infrastructure of the view from within” (Trappendreher, et al. 2020). The view from within is, in feminist science studies, the preferred ethical perspective from which to locate and situate being and knowledge as fundamentally entangled. “Braidotti’s view,” write Banarji and Paranjape in *The Critical Turn in Posthumanism and Postcolonial Interventions* (2016), “seeks nomadic transversal alliances to reconstruct a neofoundationalist ecology of belonging rooted in the non-anthropocentric radical immanence of a materialist vitalism.” This rooted ecology of belonging of new materialism should be considered one of the benefits of the view from within that feminists have been championing for decades, but which many Indigenous philosophies have practiced for millennia (Rosiek et al. 2019; Tuck, 2014; Marker, 2018).

The view from within, if not exactly commensurable, resonates with the intention of (re)building and maintaining meaningful relationships with the living Earth inherent to Indigenous epistemology. In *The New Materialisms and Indigenous Theories of Non-Human Agency: Making the Case for Respectful Anti-Colonial Engagement*, two white settler colonial and an enrolled citizen of the Kickapoo Tribe of Kanas write in response to a lack of engagement with Indigenous philosophy in new materialist literature and research: “[I]gnoring Indigenous theorizations of non-human agency involves a performative contradiction with the emphasis on the ethics and politics of social inquiry claimed as a promise of new materialist philosophy” (Rosiek et al. 2019, p.2-3). As Rosiek et al make apparent, and as others have also discussed (Todd, 2016; Legrange, 2018; Tuck, 2014), Indigenous philosophy has been engaging and thinking with the nonhuman world for a very

long time. Avoidance of this material by Westerners can partially be described by white fragility and white privilege write Rosiek et al (2019, p. 4). It is of course very important and crucial not to continue appropriative colonial logics when engaging respectfully with such knowledge, but as mestizo Ecuadorean artist Oscar Santillan has stated about his 'antimundo' concept and practice, these ancestral knowledge systems can offer ways of "embracing realities that do not yet fit into our world"(Santillan, 2021, n.p.). In times of massive global change and unrest, renewed stories, modes of address, and realities, are all desperately needed to bring societies towards reconciliation with their histories and tendencies, and to make better informed decisions and practices that are explicitly anti-colonial, anti-imperialist, and non-extractive.

GEOCINEMA's *The Making of Earths* (2019-20), in the same exhibition at ZKM (2020) mentioned above performs an analysis of the infrastructures that surveil and quantify the Earth for the purposes of capital and climate change, complicating an easy distinction between the values of sensing and measuring in times of growing inequity and climate breakdown. When in 2014 I attended the Anthropocene Campus at Haus der Kulturen der Welt in Berlin, the Otolith Group showed *Medium Earth* (2013), which tells a story of a person sensitive to earthquakes, who understands her body as a map of the Earth, and whose pains she understands as localized volcanic or earthquake events, allowing her to predict and warn communities in different parts of the world about impending activity. Finally, a very significant film for me is Allora and Calzadilla's collaboration with author Ted Chiang; *The Great Silence* (2014). This short film was shot in Puerto Rico in and around the now destroyed 'largest radio telescope' in the world, the Arecibo space telescope in Esperanza, the home of a critically endangered species of parrot. In this film, the intelligent parrots are attempting to communicate their plight

to the humans who are devising all manner of technology to search for intelligence in outer space, rather than right here at home. The work of Oscar Santillan, GEOCINEMA, the Otolith Group, and Allora and Calzadilla each challenge the norms of western societies' knowledge practices, decentring and queering them.

Santillan's 'Desert Eyes' *Solaris* (2017) project is a quite astute and formidable project that my own work resonates with. In it Santillan harvested sand from the Atacama Desert, and melted it into lenses. The site of Atacama is a site of large telescope arrays and Indigenous communities and histories. He made the lenses, crucially, without filtering the sand, allowing the lenses to have impurities. He then photographed the same desert landscape with these lenses - with 'its own eyes', suggesting that the desert can see itself, or that we humans can gain a perspective on the desert, through its own eyes – so to speak – recognizing it as a sentient place or living creature. "The captured images go beyond representing the landscape; in *Solaris*, the desert is an observing subject rather than a passive object to be looked at," reads the project webpage on University of Toronto's Blackwood Gallery website.[15] "The scale of reality is not the scale of politics. I am deeply interested in expanding our sense of what is possible; of the limits of reality itself." writes Santillan in a recent interview (Santillan, 2017, np). He continues, "being political right now is about being able to expand our sense of what is possible, to show actual physical proof that unknown layers of reality exist." We can understand this need to rethink reality, time and space, our representations of them, due to the implications of interdisciplinary studies and platforms such as Anthropocene research. How we've been socialized in the west to understand the world is so deeply flawed that the habitability of the planet is now on the brink of collapse for many species of plant and

[15] Please see: https://www.blackwoodgallery.ca/program/solaris

creature. The creation of an indifferent mechanical universe renders the world and its aspects into a commodity, valued only in terms of toxic economic categories, making it extractable, and leaving any semblance of ethical co-habitation far behind. A compassionate, participatory universe also exists, a sympathetic reality and entanglement with materials and non-human bodies, from particles to stars, blackholes to lakes and iceshelfs. This is what the holographic traces an intuitive intradimensional line across, through, and around.

In artist and researcher Susan Schuppli's long awaited *Material Witness* (2020) book, documenting the various fascinating ways matter records events, thereby becoming evidence through juridical and scientific practices, she writes convincingly that "[a]s evidence for events migrates, and assumes ever more materially dispersed and datafied arrangements, our critical investigative practices must take into account alternate modes of witnessing that operate across scales and entities–including the technical and more-than-human – if, that is, we are to challenge the powerful contexts and institutional formats that determine the particular relevance of events or, indeed, to invent new ones." (p.309). Crucially, she insists on the "the agency of the aesthetic inasmuch as legal agency" (p.286).

With the holographic as our conceptual and practical tool, we can begin to hold and merge various formats and modes of observing simultaneously, allowing for differences to remain generative and operative in the phase-space of the quantum ecologies of the sites and practices under consideration. This is an experimental theorizing, specifically due to its ethico-aesthetic position, its radical openness to the wisdom of the rocks, the knowing of the elements, their memories and communications, the living landscapes themselves. I will now begin the more

thorough explication and exposition of the holographic toolkit as a critical and creative form of creative critical place inquiry.

Chapter 3: *A Borderline Conception Lying at the Extreme Edge of the World of Appearances*

09. *A Borderline Conception Lying at the Extreme Edge of the World of Appearances,* (Still) Jol Thoms, 2019. 3 channel HD a/v composition.

3.1 Critical Interferometry: Transcoding the Holographic of a Landscape-Laboratory

[A shorter version of this chapter appears in the edited volume *Diffractive Reading: New Critical Humanities.* Kai Merten, Ed. Rowan and Littlefield 2021]

Link to media:

https://vimeo.com/401657551

P/W: Appearances.

10. *A Borderline Conception Lying at the Extreme Edge of the World of Appearances,* (Still) Jol Thoms, 2019. 3 channel HD a/v composition.

While a Fellow of Akademie Schloss Solitude in 2017, an artist's residency in the forested hills outside of Stuttgart Germany, I received an invitation from the Irkutsk State University's physics department to travel to and document their winter assembly of the so-called *Gigaton Volume Detector* (GVD) in southern Siberia. The GVD is a cubic kilometer array of submerged optical modules in a matrix formation that utilizes the density and optical qualities of water to detect interactions of imperceptible uncharged particles that rarely decay within it. With the support of the artists residency, I travelled deep into the Russian wilderness to Lake Baikal during the month of March since this is the time of year that the thick ice of Baikal's surface can support trucks, workers, and other forms of equipment necessary for the complex processes of instrumenting this unique lake to become a vast subatomic particle detector. Travelling at any other time of year to this *landscape-laboratory* would be beautiful and

wonderous, but since all optical and network equipment of the detector is submerged within the lake - rendering it eco-technical and revealing it as cosmological - there would be nothing of this process, this occluded transformation of *lake-becoming-telescope,* to witness. That is to say that I was keenly interested in documenting the process and the place. Fieldwork and research on and in this complex site formed and informed this and other published texts, as well as a multi-channel video work that has been exhibited in Pisa, Italy and in London at Ambika P3.

The water that we walked, drove, and hiked across; the water that held up trucks, machines, cables, and trailers - the water as infrastructure, in various states of support, is the same water that makes the telescope possible or thinkable. The hydrogen particles of water also meet imperceptible particles from all regions of timespace, rendering the lake an opto-technical physics experiment. The waters transitional icy surfaces and volumes importantly also contain and explain the dynamic and transformative events that occur within it through its own seemingly abstract geosemiotic gestures and self-representations. The self-similar nature of the cosmos and some of its processes are projected, perhaps not surprisingly, through this planets very rare, some might say sacred waters.

11. *A Borderline Conception Lying at the Extreme Edge of the World of Appearances,* (Still) Jol Thoms (2019). 4km's from the shore, the GVD being assembled: deployment camp over the deepest region of Baikal.

The category of 'landscape-laboratory'[16] is one I use to refer to a relatively new genre of experimental observatory that is at the same time as being located in and imagined by the discipline of physics, is also significantly embedded within eco-social regimes of environmental stewardship. The *Gigaton Volume Detector*, for example, is hosted by the UNESCO World Heritage site of Siberia's Lake Baikal, the world's oldest and largest freshwater lake – holding approximately 27 percent of all the worlds melted fresh water. Landscape-laboratories then have a crucial and specific relationship to land, territory, and ecology. They are truly vast assemblages – built on the scale of *cubic kilometers* – where earthly bodies and elemental matters, entangled with technical, optical, administrative, and computational instruments coalesce into bizarre astronomical apparati.

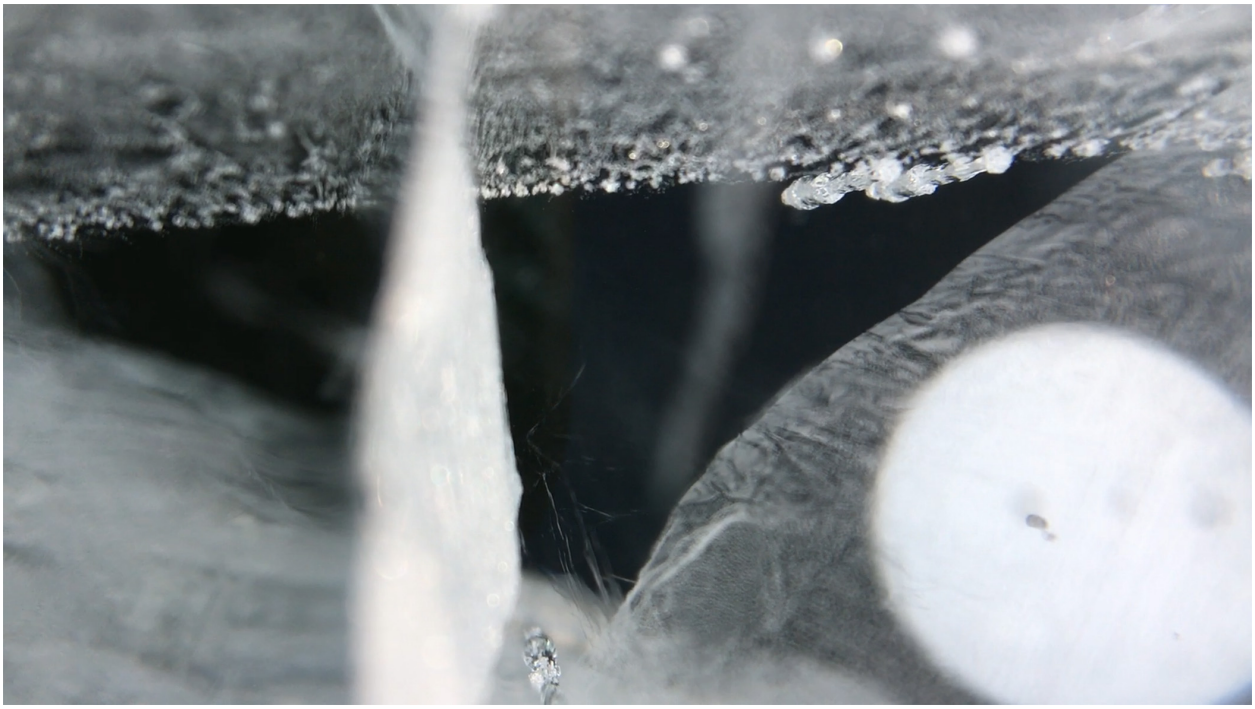
[16] I first encountered this provocative term in a conversation with the artist and 'deep-field' researcher Neal White in 2016.

Due to their enormity, the sensor arrays of landscape-laboratories can only be infrastructurally supported by planetary bodies themselves, nothing free-standing could possibly be built at this scale. Due to the extreme rarity of the events that physicists are searching for within these assemblages, what physicists call a 'low cross-section of interaction', the chance of success for discovery and measurement of the neutrino particles requires vast volumes of material. The protected planetary bodies - the lakes, seas, mountains, and ice shelves of landscape-laboratories – are, however, not merely infrastructural supports for the vast optical arrays that compose the technical milieu of the observatories, but also, and crucially, their elemental makeup is *the very condition for the detectors themselves to function:* it is the *waters* of the lake that holds the detector and holds the detectors most vital capacity to collide-with the *spooky* subatomic neutrino particles it searches. At Baikal, the lake is "becoming-telescope" and the telescope is *becoming-lake*: a series of dynamic processes that have intriguing philosophical implications that my research pursues.

The GVD seeks out 'cosmic messengers' that are non-optical, ie: not electromagnetic, and that only 'weakly' interact with 'regular' *baryonic* matter.[17] 'Weak interaction' refers to the process of particle decay, and theoretical dark matter and neutrinos, as they are currently understood, can only be detected by implication - through cascading *secondary* particle decays. Because dark matter and neutrinos are not charged, they're translucent to all of our equipment. Since they're translucent to light, neutrinos (and theoretical dark matter) can only be *inferred* by these more indirect types of observations. 'Weakly interacting' particles from

[17] 'Non-baryonic' is description of a type of mass/energy that is not electromagnetic and therefore not directly measurable or perceptible. The 4-5 % of the cosmos that we can see and measure is *baryonic* matter. The non-baryonic consists of neutrinos, theoretical 'dark matter', supersymmetric particles, axions, and black holes.

unknown regions of space meet atmosphere, meet lake, meet ice, meet hydrogen, and *cascade* into networks of epistemic practice. Its these *secondary particle cascades* which are actually detected by the optical instrumentation of the detector. The optical modules of the detector do not 'see' a neutrino. In fact, only the waters experience them directly. Optical modules tethered to code and algorithms reconstruct these cosmo-elemental *intra-actions* producing vectors and energies to be read, described, and interpellated by large international teams of researchers. But it is primarily due to natures fundamental relational capacities that the waters of Baikal can become technical, reaching into the otherwise imperceptible arenas beyond human sense or experience.



12. *A Borderline Conception Lying at the Extreme Edge of the World of Appearances,* (Still) Jol Thoms, 2019. With my phone faced down directly on the ice, cosmic visions from all scales are seen.

Neutrinos are rebellious little ghosts, imperceptible particles indicating faults in the otherwise rock-solid 'Standard Model of Particle Physics' – one of the crowning achievements of quantum physics, and indeed modern Western society.[18] The Standard Model (SM) is a system that accurately describes three of the four known fundamental forces of nature and classifies all of the known elementary particles. The neutrino however, the smallest and most abundant particle in the universe, spooks the physicist's greatest model because it hasn't followed their formulas, predictions, or generalities.[19] Anomalous neutrinos and their detectors

[18] For a recent discussion on the neutrino and their telescopy's philosophically troubling qualities, please see: Thomson, J. & Engelmann, S. *Intra-acting with the IceCube Neutrino Observatory, or; how the technosphere may come to matter,* The Anthropocene Review, Sage Publishing, 2017.

[19] The neutrino, unlike any other known particle, *oscillates*, which is a way of saying that, while the wave function does collapse when it is observed, the neutrino, unlike any other observed particle, still *remains in a state of superposition*. This so-called 'flavour' spectrum of constantly shifting weights (termed muon, tau, or electron) troubles

are therefore excellent artistic-research collaborators for expanding on an articulation of what Kathrin Thiele (2014), in reference to Karen Barad's seminal work, has called 'the quantum reformulation of ontology' (Thiele, p.211). In my artistic-research practice, deeply inspired by the thought of Barad, I am interested in "thinking [physics-] philosophy as the 'material for an art" (Laruelle in Mackay, 2012, p.29). This leads toward an artistic-research thesis that may be more akin in its written form to humanities scholarship, what I call 'experimental theory'.

As 'epistemic things' (Rheinberger, 1997), objects of and for thought, neutrinos and their detectors are also *non-retinal* in a certain art historical sense.[20] Neutrinos transgress and transverse Western European thought, offering more propositions to the list of physical phenomena that upset centuries old beliefs in mechanistic, linear spacetimes. Over the last 5 years I have worked with them in the development of a feminist, anticolonial, posthuman ethics in the realm of the quasi-discipline of art-science. Like other quantum weirdness neutrinos *oscillate* between different 'flavors': tau, muon, electron. This means their mass changes, constantly. Its wave function doesn't completely collapse when we observe it like every other observable particle's does. Famously it was the observer's measurement that collapsed the wave function, complicating notions of separation and objectivity in quantum physics since the Copenhagen Interpretation. Nature's most abundant particle, the neutrino, is not only elusive, but it remains in a constant state of change and dynamism, one cannot simply grasp it and classify it as one does every other thing in the observable universe.

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fundamentally what physicists think they know about matter and energy. For a brief discussion, please see 'Beyond the Standard Model'. https://en.wikipedia.org/wiki/Physics_beyond_the_Standard_Model (Accessed 12 August, 2019)

[20] The term 'non-retinal' was used by Duchamp discussing his 'readymades'.

13. *A Borderline Conception Lying at the Extreme Edge of the World of Appearances,* (Still) Jol Thoms, 2019. A fractured image of a water surface opened to deploy optical modules rapidly crystalizing as workers prepare their technologies.

In 1958 the waters of Baikal were planned to be drastically, if not arrogantly lowered by 5 meters for a brief hydroelectric power surge. This would cause unheard of devastation to the ecozone, the flora, fauna and future of the region. Historian of Russian Environmentalism Nicholas Breyfogle writes how during that time of rapid industrial acceleration biologist M. M. Kozhov's public resistance to the plan initiated a movement that would develop into a profound environmental awakening across all of Russia.[21] "It was in the context of the rapidly growing consciousness of the effects of industrial development on Baikal that the 1958

[21] This event is analogous and coeval with Rachel Carson's pivotal work in the West, *Silent Spring,* considered to have, "altered the balance of power in the world, …. [and] partly responsible for the deep ecology movement and the strength of the grassroots environmental movement since the 1960's" (Hynes, P. 1992). For an excellent review of Baikal's coming into being as a protected national symbol of Russian environmentalism, please see: Breyfogle, Nicholas B. "At the watershed: 1958 and the beginnings of Lake Baikal environmentalism." *Slavonic & East European Review* 93, no. 1 (2015): 147-180.

conference (that proposed Baikal as a site of extraction and industrial development) took place and that a public defense of the lake came alive" (Breyfogle, 2015, p.166). This public defense of the *hydrocommons* (Neimanis, 2009) reshaped the ecopolitical landscape of Russia.[22]

Lake Baikal has been populated by people and cultures dating back at least 4,000 years, and the majority of these people have had very strong ties to the 'sacred waters' of Baikal, their origin stories being located in these waters, their modes of existence being reliant upon them, their gods inhabiting, if not existing as this majestic lake. "[A]cross human history," writes Breyfogle, "water represents both the origin of reality and the transformer of realities" (2016, p.34). The capacity for water to traverse the knowable and perceivable reaches, outside the mathematization and categorizing practices of a hegemonic master-discipline like physics, allows us to revel in connection rather than separation, as these waters of Earth meet distant cosmic events. The waters, instrumented as telescope, brings challenges to Western, or rather Northern, models of reality and understanding.

The planetary bodies - lakes, deserts, mountains, and ice shelves of landscape-laboratories - are not merely infrastructural supports for the vast nuclear-optical arrays that

[22]The term *hydrocommons* emerges from the thought of Astrida Neimanis, specifically her 2009 article *Bodies of Water, Human Rights and the Hydrocommons* where she introduces another generative concept of the 'amniotic onto-logic', each composed for "thinking about bodies of water "in common" [which] offers not only an ecopolitical alternative to a human rights paradigm, but also provides a key opening for embodied radicalization of the commons more broadly" (P176). Further: "Like a traditional environmental ethic stresses a logic of preservation or conservation (cf. Evernden 1985: 4). The onto-logic of our bodies of water suggests movements of nurture, care and sustenance. Yet amniotics also reminds us that regardless of our human foibles or efforts, bodies will continue to differentiate, to proliferate. All watery bodies are moving (flowing, melting, evaporating) at one speed or another. Hence it seems we must pursue an ecopolitics that can accommodate the seeming contradiction at the heart of an onto-logic of amniotics: endurance and energy, sustainability and proliferation"(P.177). A *hydrocommons*, then, is the pursuit of the acknowledgment that all bodies of Earth are hydro bodies, existent and dependent on water, and therefore all bodies, human and otherwise hold water in common, though here, Neimanis is thinking with Hardt and Negri (2004) exerting influence on the ecopolitical role of protection and stewardship to those responsible for its toxifications, over-consumptions, and exploitations.

compose the technical milieu of the observatories and detectors, but crucially, it is their specific elemental makeup that is the very condition for the detectors themselves to function, technically and optically. As visualization system it is the *water* of lake Baikal that holds the detector's most vital capacity to meet or collide-with the uncharged imperceptible neutrino particles it was built to detect. It is the water that supports the construction, and it is the water that already knows and holds all of the information that physicists are searching for. Indeed, the Lake is ancient and wise, an ancestral body bringing, holding and generating life itself.

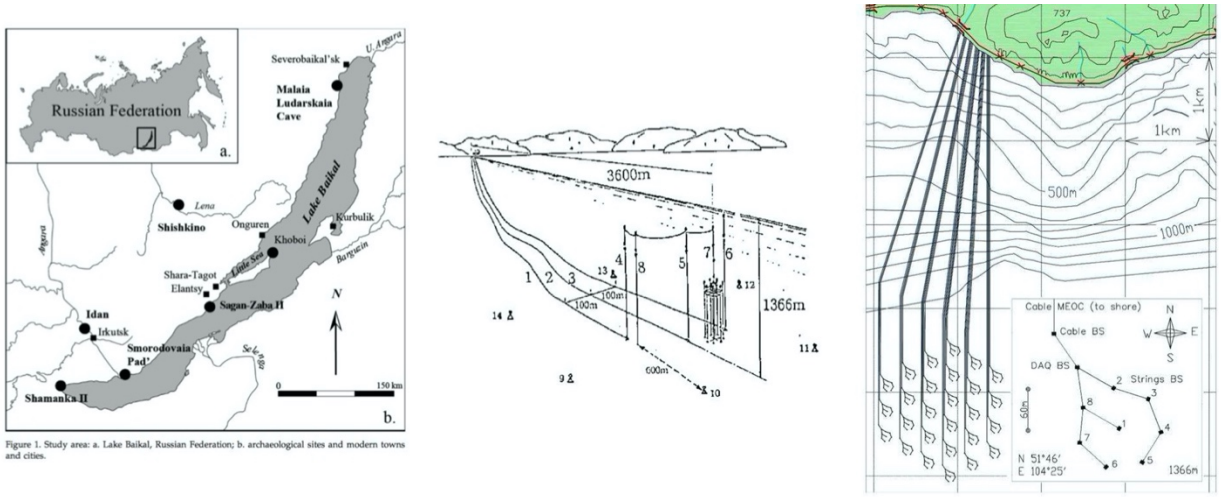
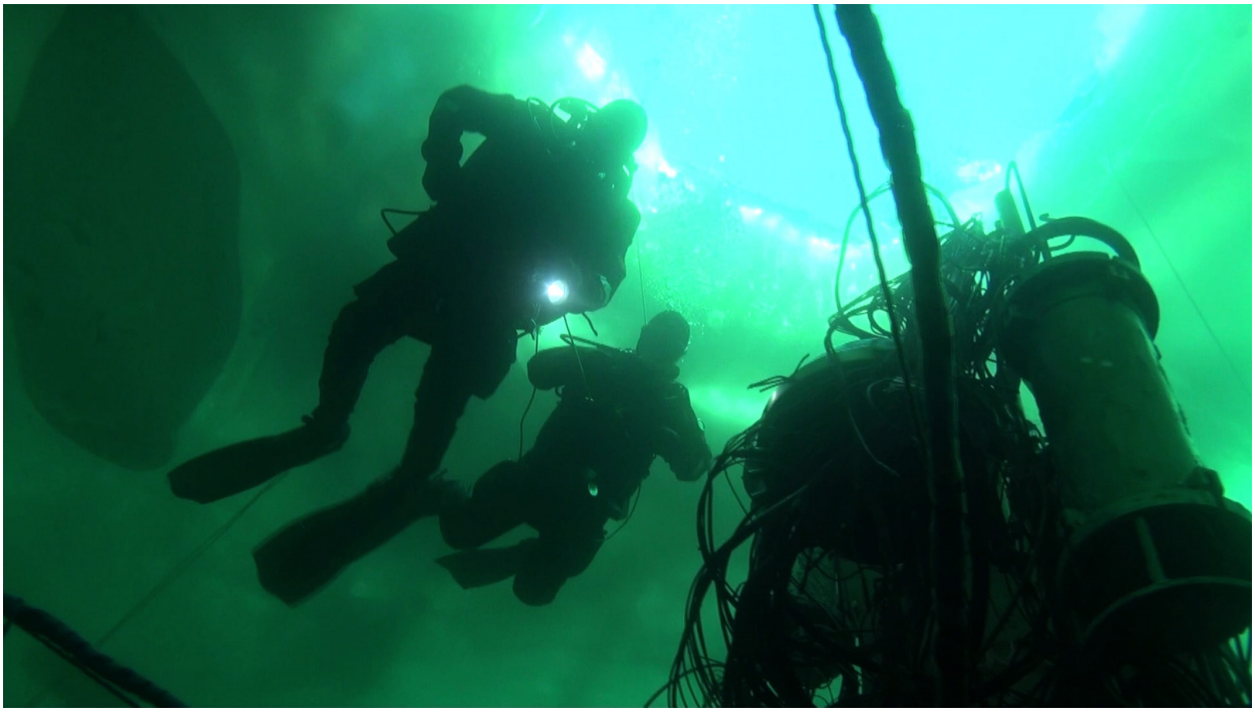


Figure 1. Study area: a. Lake Baikal, Russian Federation; b. archaeological sites and modern towns and cities.

14. Cartographies and Topologies of a Landscape-Laboratory in Siberia's Lake Baikal: GVD.

We've encountered Karen Barad's diffractive methodology where, "one is attentive to fine details of different disciplinary approaches" (2007, p.93). In my own artistic practice excess, density and iteration are also helpful, meaningful, and generative for detecting overlooked patterns and relations. Since diffraction, 'attends to specific material entanglements', as 'a way of understanding the world from within and as a part of it' (Ibid: p.88), it remains for my practice an invaluable method for engaging and attending to the multiply entangled 'characters' (mineral species, elemental bodies, flora and fauna, particles, forces, historical figures) of a site. In my practice I diffractively read and write (or *transcode*) landscape-laboratories through their lively material and elemental conditions, their local and historical situations, to situate physicists' apparatuses in the underwritten contexts that generally lie outside the scope of a physicist's description. My work operates outside of conventional expectations of scientific communication, challenging implicit assumptions in meta/physical concepts of nature, technology, ecology, and the human that "enables a critical rethinking of science and the social in their relationality" (Barad, 2007, p.93).



15. *A Borderline Conception Lying at the Extreme Edge of the World of Appearances,* (Still) Jol Thoms, 2019. Scuba divers inspect deployed technologies.

The GVD's cubic kilometer scale is necessary due to the severely rare interactions of the abundant neutrino particles with our 'regular', baryonic type of charged, luminous, optical matter. This new genre of experimental physical observatory operates quite outside of traditional limits and ideas of perception, technology, scale or '*nature*' – and this is what interests me about them: their *reach* – only conceivable due to reality's radical, integrative relationalities; its plurality and *inseparability* (Silva, 2016). The fundamental inseparability of nature at the scale of quantum challenges centuries of philosophical and political thought yet has yet to really refract in and through our political lives.

As I noted above, the thick winter ice of Baikal supports the heavy equipment and workers above its deepest region allowing them to precisely instrument the spectacular lake. If we imagined ourselves as inseparable from the Earth's bodies and elements, it is unlikely that

so many of our societies would so willingly or blindly devastate and toxify them. The implications of quantum mechanics has yet to seep into our ecological thinking either. If we were to think of a quantum ecology, it would necessarily become an eco-social political philosophy, a new cosmology. I find it strange how most of our contemporary technologies rely on quantum physics, yet few of its wider ontological implications have explicitly entered into or reorganized our social thought.

What is crucial here is that distant events from all regions of spacetime are made legible, connecting with/in the lake-as-telescope, complicating notions of scale, in/separability, and non/locality. The telescopes existence insists on a radical relationality beyond the limits of four dimensional spacetime, that points to an 'existence beyond experience' (Silva, 2021, np). Radical relationality implies that nothing in the universe goes untouched by any other piece of it, insisting on a Leibnizian *plenum* and a reorientation of our understanding of each and every body. Distance does not separate us from the cosmic microwave background, it is implied and active at every location. It is only agential capacity, as Barad insists, that is limited or bounded by social constructions, dominated as they are by white supremacist institutions and histories.

16. *A Borderline Conception Lying at the Extreme Edge of the World of Appearances,* (Still) Jol Thoms, 2019.

"We are created in water, we gestate in water, we are born into an atmosphere of diffuse water, we drink water, we harbour it, it sustains and protects us, it leaves us—we are always, to some extent, in it. The passage from body of water to body of water is never merely metaphoric, but rather radically material. The watery condition of being literally flows into, out of and from beings themselves in a multiplicitous hydrological cycle of becoming—evolutions of gestation, repetition, differentiation and interpermeation" (Neimanis, A. 2009, p.164).

Neimanis' notion of an *amniotic onto-logic* that links all planetary bodies of water, human and more-than-non-human, is a concept that I find useful for thinking the precarious commonalities and relationalities across various types of characters, beings, and practices that

my work addresses.[23] In discussing how water relates beings and spacetimematter(s), as well as some of the sites environmental history, some of the complex overlapping waves inherent to the *holographic* site of the GVD is revealed – laboratory becomes landscape, and vice versa. Accessing 'the holographic' of a site or an artwork depends, of course, on the sensitivity and openness of a reader, their willingness to incorporate into their field of experiences the *more-than* of its non/local, multi-dimensional topographical layers – its poetries and polysemy. A radical 'debordering', a radical, transversal, *more-than*-relationality works against the flattening logic of disciplinary systems and geometries of power, asking and allowing for more dimensionality into our senses and experiences, expanding the conditions of possibility by revealing how much more we need to account for in any ecology (of practice).

[23] "An onto-logic is a common way of being expressed across a difference of beings. As opposed to the way in which ontology is traditionally understood, an onto-logic does not propose to solve the question of Being, nor does it purport to reveal or describe all of being's facets or potential expressions. Like a template, an onto-logic can highlight something that helps us understand a common how, where, when and thanks to whom that seemingly disparate beings share." (Neimanis, A. 2009). See also footnote 21 above.

17. *A Borderline Conception Lying at the Extreme Edge of the World of Appearances,* (Still) Jol Thoms, 2019.

In a physicists account of a detector, the waters are excluded from the meaning of mattering, at least in so far as it is a cultural body with deep meaning and resonance for many forms of beings. Instead, water is rendered as merely technical, a sort of happy coincidence, but essentially a void.[24] The GVD however, is developed as a radically, inhumanly sensitive device, capable of peering into regions of the insensible and imperceptible, beyond thresholds of perception - only by transgressing and mutating onto-epistemic boundaries: only by *becoming-lake* is new knowledge of reality and the cosmos formed. This becoming lake of technology sounds to me like the reinsertion of the human back into and within the planet, no longer outside, coldly detached. Getting closer to the *material* - and away from the cognitive

[24] I will state that while technically, in physics literature, the water is merely a medium for particle detection. But while on the site with the director Nikolai Budnev, it was clear that the men who go out on the lake each winter to work on the GVD, are invested in this project because they get that time out there, in the beauty and power of Baikal. The people from all over Russia travel tere to work, but to also spend their time in that magical, empowering place.

injustice (Vanishavantan, 2018) of many scientific cultures and epistemes - is one way of gaining vital understanding of the lively agential capacities of earthly materials and nonhuman bodies - their complex modes of symbi-o(n)tic co-existence.

In getting closer to the elements that are shaped and formed, absorbed into experimental practices of sense that hold so much power in our worlds, we can continue the critical journey of *situating* current scientific knowledge outside the mind or math of the scientific paradigm, locating them, as Barad says, 'within and as a part of the world'. Situating physics and other sciences is of course of critical importance due to their entangled histories in war, colonialism, weaponry, and climate devastation. Situating practices, as Latour and Haraway are so well known for in STS, brings responsibility back to the developers of technologies and knowledges. In attending to the *matters that matter* in these eco-techno-cosmo-logical assemblages, something urgently echoes. An essential part of my practice as an artist is the precarious attempt, however belated, failed, in/accurate, or otherwise, of opening an inviting space for these minor reverberations to accrue, spread, proliferate, while paying homage to the lively (things and relationalities of) Earth.

18. *A Borderline Conception Lying at the Extreme Edge of the World of Appearances,* (Still) Jol Thoms, 2019. Here an image of a single Optical Module before it is sunk into the Lake.

A diffractive aesthetic *isomorphically projects* – it renders the flattened spaces of a discipline's boundaries into *n+* volumes by transcoding the extra-disciplinarity of a landscape-laboratory – accounting for it geographically, archeologically, geopolitically, historically; as a resource, a technology, and as a living, perhaps celestial creature – beyond western understanding. Taking more of the apparatus – its surroundings – into account is a process of isomorphic projection that adds breadth, depth, and form, that accounts for the extra-dimensionality of the site, causing generative interference patterns to emerge along the way. These dimensions and patterns reveal relations that can both undo the atomization of the real while revealing the potential for lively communicability and sensitivity across all things. This brings us back to the concept and model of the holographic.

Technically a holo*gram,* is the appearance of a material structure that emerges through interference patterns of diffracted light. Michael Talbot, author of *The Holographic Universe* (1991) whom we encountered above writes that, "a hologram is a three-dimensional photograph made with the aid of a laser… When the film is developed, it looks like a meaningless swirl of light and dark lines. But as soon as the developed film is illuminated by another laser beam, a three-dimensional image of the original object appears" (p. 14). A holo*graphic* as I am developing it here, however, is *not an image* or physical structure but a multiple, dynamic, entangled, *extradimensional object* of and for thought, experience, and aesthetics - a coherent *phase space* of matter and meaning that is not and cannot remain flat, because, "[t]he total range of issues involved in meaning cannot be resolved at one 'level' or locus, or within one dialectic" (Wagner, 2001, p. 127). It is *graphic* in the sense that it maps, traces, and writes connections, revealing the troubles of more-than-human life. In that networking that reaches and traverses, something intangible or ineffable seems to reveal itself. This may be what makes the GVD and other landscape-laboratories 'enunciative', making the parts of itself that are larger than itself known. At any coordinate in the holographic, all other dimensions, agents, waves, forces, or disciplines are connected and apparent. In recognizing the multidimensionality of the site and this form of thought, these bonds become apparent, their forms however abstract, emerging. The criticality of the interferometric is due to - and a result of - its capacity to engage such multidimensional, extensive excess - an excess inherent to the holographic of my practice, to the 'ecology of practices' (Stengers, 2005) intermingling in the diffractive transcoding of the landscape-laboratory.

To borrow from and think critically with the concepts and languages of physics allows me to speak with and to the discipline, to make relationships that allow me to instill minor gestures of careful and loving critique within a dominant, hegemonic, and generally gated discipline.

19. *A Borderline Conception Lying at the Extreme Edge of the World of Appearances,* (Still) Jol Thoms, 2019.

Rather than voiding the relation of the laboratory to the earth or its materials, these diffractive readings and holographic literacies expose overlooked yet proliferating dynamic relations through iterative figure-ground reversals. In doing so a diffractive transcoding situates, expands, and makes sensible the lively, agential capacities of matter and meaning enacted and opened by this new genre of physical observatory. The GVD's multiple dimensions expand and condense into forms where meaning is at its most abstract, found throughout my documentation quite literally where natural boundary layers meet and exchange, where material states shift. There, a *holographic* is at work and presents itself. A diffractive aesthetics is a process of mapping and/or inheriting from those hyperspatial resonances through *isomorphic* practices that expand and condense geometries of difference in spacetimematter.

In my practice, as I get closer to the agential capacities of materials, waters, minerals, and species I also become more aware of and more entangled with the intangible. "Intangibility,"

writes Macarena Gomez-Barris in *The Extractive Zone*, mediating an indigenous Andean phenomenological understanding, “names for me the capacity of life otherwise to reroute itself around commodification and scientific classification” (2017, p.18). This ‘rerouting’ bypasses the logics inherent to what Whitehead termed the *bifurcations of nature* – the processes of separation that Denise Ferreira da Silva also locates in the history of the development of modern science – allowing us to again link beyond what dominant Western cosmologies permit, and in fact to think the beyond of ‘nature’, rubbing up against the extreme edges of conceivability, and the limits of vulnerable human understanding. The vulnerability of human understanding, the precarity of many forms of knowledge (precarious because they are rigid, definitive, or universalist), I believe, leads to a fearful, therefor violent condition. Feeding into that fear is, again, the construction of an indifferent universe. A material world void of spirit or ineffability is a world without connection or embrace, a manifestation of a truly troubled and unjust cosmology.

20. *A Borderline Conception Lying at the Extreme Edge of the World of Appearances,* (Still) Jol Thoms, 2019.

The critical interferometry[25] of the holographic gestures to the excessiveness of the *whole*: the disciplines, contexts, material(itie)s, agents, histories, environments, and forces operating on and across scales and bodies, both perceptible and imperceptible - both in and out of human conceptual capacity. It does not presume to account for everything but continues to expand the field of possible encounter and accountability. In doing so, like much of Stanislaw Lem's science fiction, the limits of human rationality are exposed in the process.

[25] In optics and physics the reading or measuring of a diffraction pattern is done through a process of 'interferometry', literally the measuring of interferences. Diffractions' abilities to reveal, leads to unprecedented discoveries in the realm of matter, energy, nature, and the cosmos, and of course in our theories and disciplinary boundaries, rewriting our very understandings of identity and reality. In 2017, diffraction patterns of gravity waves from colliding neutron stars were used to discover and sonify perturbations in the very geometry of spacetime itself using a set of 2 kilometre laser "interferometers". An excessively delicate laser beam, arranged in a manner that it is undisturbed from any local planetary vibration (as though it were perfectly floating in space), registers these gravity waves through the self interference of this split laser beam as it is perturbed by the gravity wave. 3 interferometers of this scale and type are calibrated in different locations across the planet to verify one another's perturbations, but also to detect the trajectory, the direction in which the wave is travelling. In this case critical interferometry is then the transcoding of diffractions in theory, practices, and sites.

Attending to the material-discursive entanglements and abstractions of Baikal's 'Gigaton Volume Detector' (GVD), or any landscape-laboratory, what always resurfaces is the problematic role of physics' generalized bifurcations, its totalizing logic, and its obsessive 'mathematization of nature' (Meillassoux, 2007) which tends to valorize and give legitimacy only to that which can be counted or quantified with western systems of metrology. As an 'enunciative assemblage'[26] (Guattari 2012), an instrument of meta/physical knowledge that *de*borders some of the bifurcations that have characterized the myth of progress inherent to modernity's technoscientific project, and by resuscitating 'that which speaks but cannot be spoken' (Campagna, 2019, p.139)– the ineffable sacredness and magic of the natural world – a holographic literacy helps to make explicit the "primordial importance to the making of relations" (Stengers, 2018, p.146).

What my works do, is reassert the primacy of relations in a hope for a reinvigorated idea of the Earth as an ancient, sacred and wise body – divine, filled as it is with the life-giving waters of the cosmos, where watery things learn and love, where all regions of the cosmos meet, the only place we will likely ever be able to perceive communications with; where complex life *actually* emerged from: from within the biota, minerals, forces, bubbles, molecules, waves, metals, clays, and liquids of *this* unique, gorgeous, knowing planet. This re-enchantment of the world follows in the footsteps of an agential realist account that finds posthuman agency in the networks and intra-actions of non/humans, technologies, phenomena, matter-energy, nature, and cosmos. As

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[26] "Enunciation is like the conductor who sometimes accepts his loss of control of the members of the orchestra: at certain moments, it is the pleasure of articulation or rhythm, if not an inflated style, which sets out to play a solo and to impose it on others. Let's emphasize that if an Assemblage of enunciation can include multiple social voices, it equally takes on pre-personal voices, capable of bringing about aesthetic ecstasis, a mystic effusion … - as much as an ethical imperative." Guattari (2012), p.210.

discussed earlier, these articulations of non-human agency also resonate with some Indigenous knowledges, though this is often an overlooked corpus of thought. As Rosiek et al. mention: "Choices are being made about which literatures are worth the effort of engaging… There are also complex disciplinary and intersectional dynamics contributing to the lack of attention to Indigenous studies writing about non-human agency in the post-humanist social science literature" (2019, p.3). Since the holographic has been a useful tool harnessed by both non-Indigenous and Indigenous scholars, it seems like a very good candidate for the continued development of a new knowledge that is respectfully anti-colonial in its approach to native/science(s) (Cajete, 2000). In what follows I will begin to unpack other knowledge traditions that are informed by mystical and spiritual understandings to further develop the parallel acknowledgments of more-than-human phenomena and agencies.

21. *A Borderline Conception….* in the exhibition Rhythm of Space, Museo d'ella Grafica, Pisa 2019

3.2 *The Ineffable at the Heart of All Things*

A Borderline Conception Lying at the Extreme Edge of the World of Appearances documents the ongoing reconfiguration of the natural sciences' limits, infrastructures, and knowledge systems. It is punctuated by excerpts from a book written jointly by Carl Jung and Wolfgang Pauli, a depth psychologist and a Nobel prize winning physicist, each interested in the 'psycho-physical problem' expressed in quantum physics' issue of the observers influence on systems, and experiences of what Jung termed 'synchronicity', commonly understood as uncanny chains of events that seem to transgress typical notions of the real. By positioning this

landscape-laboratory as a non-standard philosophical object, this work contributes to an ongoing project that destabilizes empiricist assumptions and reconnects bifurcated systems back towards understanding them as (r)elational wholes. I will discuss the bifurcation of nature further on in this chapter. Decentring binary classificatory hegemonies of western epistemic practice draws on an emphasis of the promiscuity of the elemental in the relation to scientific knowledge production at the site of the Gigaton Volume Detector.

As my work has developed over the course of this PhD project it has become more critical of reductionist/positivist sciences. There are severe systemic issues that have been born in the philosophies and metaphysics of Western cosmology since the Renaissance. In the following section on the *mathematization of nature* and its bifurcations I will discuss quantification and the *ineffable*, or; the cosmologies of *Technic* and *Magic;* and the dis/enchantment of the world. The following books discussed in this chapter fed directly into my practice and consideration of the material I was working and connecting to.

One of the most profound reading experiences I had during my research was from Marxist philosopher Federico Campagna and his conception of the *cosmogony of Technic,* premised as he describes on an 'absolute language' (Campagna, 2018) which he describes in the 2019 book *Technic and Magic: The Reconstruction of Reality*. This book describes two competing, interconnected worlds, worldviews, and cosmogonies: Technic and Magic. *Absolute language,* at its barest, can be considered the systematic requirement in western capitalist societies for any and everything to be numerically or linguistically captured, counted, or described, and helps to defines the cosmogony of Technic. This of course feeds into the extractive impulse at the heart of modernity, turning all living systems into extractable,

numerical, economical possibilities. It is the Pythagorean core of the *Technic cosmology* from which all other laws about seriality, data, and information emerge; the mathematical tenet that attempts to destroy the possibility of poetry and art; the desire for everything to be classified into primary and secondary qualities, into binary positions; this is also the very logic at the heart of western cosmology of extractivist racial capitalism that holds the world hostage.

We witness this quantitative mania operating within all frameworks of neoliberal society, its institutions and media, its rampant processes of financialization and that determine *productivity* and GDP as the measures of the good and the real. This total reification of subjects and objects might be an extra- or anti-Terrestrial schism intent on destroying complex life on the planet.[27] Of course there are many names for this particular state of modernity that consumes and metabolises the living forces of the planet, but Campagnas' rare background in the mystical traditions of world religions and Marxism attest, there is something very interesting about designating Technic as a cosmology, and countering it with the ineffable experiences of 'Magic'.

Magic, analysed comparatively to Technic offers a form of solace or resistance to the cold, detached, and indifferent universe of Technic and its neoliberal order. "By already inhabiting a different architecture of reality, Magic's person creates an immediately effective alternative to Technic's world-making. Such a course of action doesn't seek to dialectically overcome the present, but rather to move beyond it," he writes (2019, p.219). The Ineffable dimension of Magic, "turns all entities into centres", and refers to the living life and liveliness at

[27] "As Polanyi wrote, the, 'secular religion' of the market is not *of this world.* […] To reappropriate the Earth for ourselves is to struggle against this invasion by these sorts of extraterrestrials" (Latour, 2018 p.89).

the heart of things (without their being wrapped and reduced to solely their linguistic dimension) (Ibid, p.164). This can also be understood in terms of mythic thinking which, "perceives within the world a field of force, 'which permeates all things and events, and may be present now in objects, now in persons, yet it is never bound exclusively to any single and individual subject or object as its host'" (Cassirer quoted in Campagna, 2018, p.151)

The Magic cosmogony suggests a resistant seed at the heart of all things Campagna explains and is also operative within Technic's cosmological system as its opposition but evading all attempts to describe and capture it from its opponents forms of logic or sense. Since Technic is founded on *absolute language*, the proposition that the unspeakable "inhabits the heart of every single linguistic construct," delineates a powerful fracture along the foundations of Technic's hold on the world (Ibid. p.175). Campagna, analysing Sufi, Tao, and Hermetic traditions argues that the Ineffable is the primal tool, ever present, a fountain for us to draw strength from when we might be overwhelmingly depressed by the state and trajectory of the planet. Because the ineffable cannot be spoken, but surely emanates into and as experience of the world, Technic cannot capture it, no matter how maniacally it tries.

> "Technic is both unable to remove entirely the ineffable dimension of existence and unwilling to allow it to exceed into any 'outside' Technic's world. A living individual is thus stuck in a condition that is at once of captivity and exclusion, much like a stateless person in the deadlock of border bureaucracy. Indeed, what might sound like an abstract condition relating to cosmology is in fact an increasingly frequent symptom of psychopathological malaise, throughout our contemporary world. In most cases, this

> malaise takes the form of depression, while in fact being the symptom – the unnecessary, unavoidable symptom – of a far deeper, metaphysical condition. (Ibid. p.232).

Technics' exclusionary capitalist tactics overwhelms the planet, and Campagna argues that we must again compliment the 'double aspect of reality' with the cosmogony of *Magic,* which takes the Ineffable as its transcendent structural core of existence and emanation. In the following quote we can already see how this might be very meaningful for this project,

> "What do we mean as the ineffable 'as life'? Defining the first principle of Magic's cosmogony and cosmology, intends to present Magic's reality as a continuum between the two poles of ineffability and language, existence and essence, […] Every single thing that exists, whether material or immaterial contains both these aspects: a living dimension of ineffable existence, and an object like dimension that is susceptible to linguistic analysis" (Ibid. p.134).

It was on encountering Campagna's historical and comparative analysis in *Technic and Magic* that my orientation and focus started to shift, that I began to understand my project in relationship to competing cosmological impulses, which soon manifested in further readings from various disciplines which will be discussed further on in the thesis. In the serializing world of Technic, "The imperative of limitless production is their *only* possible ethics" (Campagna 2018 p. 78). The colonial-extractive suggestion of limitless production is only possible in a disenchanted

world. Tuck quotes an interview between Leanne Betasamosake Simpson – a Michi Saagiig Nishnaabeg scholar, writer, and artist – and Naomi Klein, "The act of extraction removes all of the relationships that give whatever is being extracted meaning" (Quoted in Tuck 2014 p.68). Decolonization is therefore also a process of re-enchantment, as Eve Tuck writes, "we discuss decolonization as always involving recalibrations of human relationships to land" (Ibid. p. 53).

Through the ecotechnical (Hörl, 2015) sites and assemblages (of thought) that this project researches as *epistemic objects* (Rheinberger) my practice develops a series of felt and situated compositions; audio-visual compositions that lure us in multiple directions towards an unbounded, non-scalar, complimentary thought or experience. My work evokes the unspeakable of experience when confronted with anomalies of place and situation in the quantum ecologies of a landscape-laboratory. In step with histories of artistic moving images, my work no doubt challenges traditional expectations about what a 'film' or video is, and they are designed to contribute to the rethinking and reforming of the agential capacities of a world in mutually entangled processes: "In other words, there are not organisms on one side and an environment on the other, but a co-production of both" (Latour, 2018, p.76). This is crucial for thinking the continuum of nature-cultures, particle-waves, and ineffable experiences that must be attributes of a new 'political' agent – an agent working on the reconstruction of reality. Artists are perhaps, at least in Western societies, conveniently located in a domain of relative freedom, speculation, and imagination to carry out these operations. The history of art is filled with associations of artists with alchemists, animists, shamans, healers and tricksters, because we do play strange roles in societies, mediating realities, futures, pasts and presents. While my identity may at times merge within some of these archetypal zones of being, I think I am doing

something quite different in my attention to theoretical analysis and experimental theorising of the holographic as a legitimate philosophical concept diffracting cosmologies of Technic and Magic, non/western and non/indigenous.

My art works re-incorporate into experience and existence what some might call mystery, quality, or essence – the Ineffable – and they intend to lure emotions and discursivity into hybrid art-science works that include writings, research vitrines, and experimental music coupled emotively and jarringly to moving images whose character may seem uncertain.[28] *The unspeakable speaks but cannot be spoken*. These compositions are inherently critical of the historical conception of a bifurcated nature, premised on math and human linguistic structure as the pillar of rationality and even reality. There is simply far-far more to the world and to experience that is outside the domain of the 'hard' sciences that claim to describe reality and where 'life came from'. Oscar Kawagley puts it quite succinctly: "With our realization that Western mathematics and sciences and the resulting techno-mechanistic inventions impact and change our thinking in ways that can be inimical to living in nature, with nature, and being of nature, it behooves us as indigenous peoples to learn both ways of knowing and doing, so that we can begin to develop a caring consciousness and a technology that is kind to our being as humans, as well as to the spiritual and the natural worlds." (1995, p.8). I am arguing that it 'behooves' *us* as western centered scholars interested in ecologies and environment to reach beyond the white Eurocentric histories and epistemologies of colonial legacy to learn and experience other ways of

[28] I have been made aware that Ineffable is also a widely cited term used by Biggs, M (2004) to refer different modes of knowledge and its articulation in relation to the concept of the exegesis or reflective account of practice as research. This is in no way, which I think is obvious as the reader continues, in relation to the mystical notion of the Ineffable as used here - as a unique uncodable aspect of reality that forms the core resistant claim against scientific mastery over all living things.

knowing and being in the world. Art can challenge a closed, limited, anthropocentric cognitive hegemony over time and space and so has a privileged position to open opportunities. In doing so it can trouble the scientific grounds of Capital's oppressive neoliberal regime and the construction of a reified, extractable Earth.

3.3 The Galilean-Cartesian Illusions

The incorporation of *qualities* back into a world dominated by quantification traces a historical narrative through the philosophy of science, in what has been referred to by Albert North Whitehead as the *bifurcation of nature,* a series of processes that have different modalities and origin stories – a series of separations, divisions, and dissections within nature's multiplicity (of which we are a part). Again, when I speak of a *bifurcation*, it should be clear that what I am speaking about are histories of socially constructed processes of division and separation, imposed boundaries. These processes are at once scientific, economic, and racial. Latour locates an important bifurcation between what he calls *Galilean objects* and *Lovelockian agents* (Latour, 2018, p.67). The Galilean objects, "make physics possible" at the expense of having a relevant perspective from *within* the earth, privileging a *gods eye view* – what he calls a *view from Sirius* (Ibid.). Stengers thinks similarly about Galileo:

> "He was, in a way, the first 'epistemologist', recruiting concepts of philosophical origin in order to present his achievement as initiating and illustrating a general method aimed at the production of valid knowledge on observable facts. […] He was the first to promote the general, unilateral authority of science, conquering the world, defining

> what really matters and what are mere illusory beliefs, thus *giving his blessing to the destruction of innumerable other ways of relating, knowing, feeling and interpreting"* (Stengers, 2018, p.143).

In the essay *After Finitude*, Quentin Meillassoux also speaks of the "successive upheavals" brought about by *Galileism*; "the general movement of the mathematization of nature initiated by Galileo" (Meillassoux, 2007, p.136). According to these scholars this *general movement,* the reification of nature, is what has enframed and entrained worlds of thought ever since, making it seem that only that which can be described by math (or language) is what is relevant. This in turn becomes the infrastructural logic of the entire econo-political terrain, the cosmology of Technic, or the neoliberal agenda which reaches right down into the subjective developmental/psychological processes of its citizens, rendering who and what is or is not meaningful.

In its time the Galilean-Copernican revolution was largely a strategic epistemological revolution against the then dominant syllogistic logic of the church and its unchecked hegemony (Silva, 2017). Looking for relevant processes to describe objective causes to phenomena was also, of course, a political project about causality and agency in a time of disproportionate power and its unchecked injustices. I am in no way disputing the relevance of mathematics and the scientific method to society here - the clarity in describing and predicting natural phenomena is unprecedented and gives us the capacity to form responsible responses to the Earth's changing formations. Rather, it is a fanatical *Pythagorean* belief that everything must intrinsically be mathematical, and therefore describable by mathematics and their

equations that is the source of so much contention, both in the world(s) and in these projects. This is a dangerous metaphysics, an implicit abstraction in the core of society that completely smothers out worlds of experience and affection. It even seems as an extra-terrestrial invasion, disguised as a logic, whose sole intent is to exhaust all life on the planet (Latour, 2018; Land, 2011 [1993]). Manulali Meyer quotes from the Dalai Lama's *The universe in a single atom: The convergence of science and spirituality* (2005):

> "The problem is not with the empirical data of science but with the contention that these data alone constitute the legitimate ground for developing a comprehensive worldview or an adequate means for responding to the world's problems. There is more to human existence and to reality itself than current science can ever give us access to." (Lama, D. 2005 quoted in Meyer, 2013)

Descartes' original concept of consciousness, the *res cogito* that separated mind from body and world emerged in the 17th century shortly after Galileo's systematization of the scientific method. Descartes *cogito ergo sum,* (*I think therefore I am) "*began a trajectory that would extend beyond the confines of knowledge to become the ruler of modern economic, juridical, ethical, and aesthetic scenes", according to Denise Ferreira da Silva (2017). Da Silva also makes a very convincing account of this in *1 (life) ÷ 0 (blackness) = ∞ - ∞ or ∞/∞: On Matter Beyond the Equation of Value,* also revealing how the Cartesian cogito passes through Hegelian and Kantian philosophy to bolster the European project of colonialism, premised as it is on a dehumanization of those which are not (White) European. The premise of scientific

rationality emerging from the cogito, is premised on *efficient causality* or determinacy and the divisory logics and classification schema of material from immaterial, matter from experience. The Cogito divides mind from matter, internal from external, body from nature, inside from outside, existence from essence, and can be said to be an origin of the 'view from nowhere'. It was also mobilised as a *proof* that Europeans were 'superior' and therefore contributed to the modes of racialization that began with the enlightenment project. Da Silva cites Hegel's claim that: "Negroes are enslaved by Europeans and sold to America. Bad as this may be, their lot in their own lands is even worse, since there a slavery quite as absolute exists; for it is the essential principle of slavery, that man has not yet attained a consciousness of his freedom, and consequently sinks down to a mere Thing—an object of no value" (Hegel quoted in da Silva 2017). Descartes formalized 'I' becomes the condition for knowledge and therefore *being human,* but da Silva notes how, for Kant, the inheritor of this formality, "humanity … already refers only to Europeans" (Ibid).

Mathematician and historian of science Marcus Appleby investigates the Cartesian bifurcation between consciousness and matter that became deeply rooted in German philosophy. He writes that, "[t]he problem of the external world and the various philosophical movements to which it has given rise (empiricism, subjective idealism, Kantianism, objective idealism, positivism, pragmatism, phenomenology, etc.) has been the dominant theme in Western philosophy for the last 350 years" (Appleby, 2014, p.27). It is through these streams of thought that the very idea of modernity was assembled, and so at the core of the epoch, a dangerous, vicious dualism. Scholars of Whitehead referring to the processes and events of what the philosopher-mathematician called 'the bifurcation of nature', write that these 17th

century philosophers, “have forced upon common sense a rather stark choice between two types of meaninglessness: either the meaninglessness of senseless but real nature or the meaninglessness of meaningful but unreal values” (Latour in Gaskill and Nocek, 2014, p.95). “What is important to remember,” Latour continues, “is that bifurcation is unfair to *both* sides: to the humans and the social side as well as to the nonhuman or ‘natural’ side” (Ibid. p.98).

What is important for our discussion now is twofold: 1. Descartes’ influence and fixation on the primary-secondary distinction which essentially, “excluded all subjective phenomena from the physical universe” (Appleby, 2014, p.11), and, 2. How, “the very arsenal designed to determine and to ascertain the truth of human difference already assumed Europeanness/whiteness as the universal measure, that is, as the bodily, mental, and societal actualization of universality” (Silva, 2017). Denise Ferreira da Silva writes how she, intends, “to expose how determinacy, which along with *separability* and *sequentiality* constitutes *the* triad sustaining modern (racist) thought” (Silva, 2017).

These practices and processes of exclusion extended beyond Europe into the African diaspora and the Indigenous Americas and became also the logic whereby ‘coloured’ humans, could rather be rendered as in- or sub- human, specifically because they did not possess Cartesian rationalism or Western ‘objective’ rational structures. Slaves were decidedly not human in the ways that European colonizers were, and even Sir Charles Lyell, the systematizer of the entire field of geology, author of *The Principles of Geology* (1845) wrote quite racist rhetoric in his geologic surveys and public lectures which Yusoff analyses in detail:

> "Lyell's comments reveal the affective infrastructures that travel under scientific reason that privileges white comfort ('anxiety') over black pain […] Lyell makes explicit in his discussion on slavery and the interspersion of these discussions through his notes on rocks and mineral resources *how* geology functions as the racial supplement to the progress narrative. This racial supplementarity of geology is not just a material replacement in the order of things, but does psychic work in assuring white anxiety so that recognition of being fully human is forestalled (and thus remains fully exploitable)" (Yusoff,. 2018, p.79).

This bifurcation of the human from one another, enacted through scientific reason for the purposes of exploitation and expropriation (that are the foundations of Capital), therefore have to be interrogated and accounted for if we are to continue using geologic categories to discuss the human-environment relationship. Yusoff shows how, "decentring Eurocentric logics is not just a theoretical exercise of decolonization but a realignment of sense through affective infrastructures, an affective mattering in the discourse of materiality and its worlds" (Ibid. p.98). The material world and its classifications, harnessed by logics of capital accumulation and power, the abstract, bifurcated 'nature' of the sciences themselves, has to be expanded and re-engineered. A non-mechanistic view of reality and nature, that quantum mechanics enables, for example, already releases some of the tensions and fanaticisms within the dominant logics of the sciences. But how can we go further to acknowledge the folly of an 'indifferent universe'?

In this section I have further built on my critique of bifurcations of the natural within the human. The mathematization of nature is a historical process that established the notion of 'limits' to nature. The systematization of the scientific method made it very difficult to quantify 'secondary' qualities, which eventually led, through radical doubt about their reality, to the eradication of them from our descriptions and matters of concern. Removing 'secondary' *subjective* qualities about the *objective* world attempts to remove the ineffable from experience, and in fact inserts a deeper split. These bifurcations proliferate as colonizers expropriate land and labor, and proliferate their scientific rationalities, or *universal reason* out into the world(s).

There are instances of scientists who are also critical of these bifurcations of nature. In the next section I investigate Wolfgang Pauli's relationship with acausal structures and irrationality: *"non-reproducible* phenomena from which no immediate inductive conclusions can be drawn" (letter to Fierz from Pauli, in Laurikanean, 1985, p.205). These documented acausal *in*determinacies reprogram what nature is and what the human's role might be.

3.4 Paulian Mysticism

> "Reality can be approached in two different ways: either via more and more detailed information obtained through the aid of scientific analysis, or by striving for a comprehension of wholeness. The latter is the path of poets, musicians, and artists, as well as practitioners of religion and mysticism. From the point of view of life as a whole,

> both ways are necessary. […] Pauli acknowledged the need for both ways, and he pursued their unification—or *conjunctio*" (Laurikanean, 1985, p.96)

> "Quantum mechanics is not intrinsically weird. It only seems weird because we insist on looking at it through Cartesian spectacles" (Appleby, 2014, p.13)

Wolfgang Pauli, Nobel prize winning physicist, co-developer of quantum theory's Copenhagen Interpretation, alongside Neils Bohr and Werner Heisenberg, was himself troubled by the total evaporation of *meaning* in the face of a mechanistic world view. In the following section I look to a historical bifurcation between determinacy and indeterminacy, or the rational and *irrational*, a specific historical view from within the physics community itself on the separation of psychical phenomena from physical phenomena. Historian Kastervos Laurikanean wrote clearly of Pauli's belief that, "Western culture after the 17th century was one sided and dangerous. […] Pauli wishes to give us a vision where…[t]he universe should again be seen as an organism, not a clock" (Laurikanean, 1985, p.200).[29] Historians of Pauli interested in his obsessions with the so-called *irrational* side of nature stress his concern that *reality,* in fact, operates outside or beyond our *merely* rational thought. After the explicitly non-mechanistic findings of the Copenhagen Interpretation Pauli believed that the most important project of his time was to then come up with *an entirely new conception of reality itself*, one which included what we might call the *ineffable*, the mystical, *spirit*, or the acausal. In a letter to his long-time

[29] Whitehead's *Science and the Modern World* (1925) also develops an organicist theory of the universe in response to mechanized evolutionary nature.

collaborator and correspondent Markus Fierz, he wrote, “The symbol which expresses reality validly and adequately must, rather, differently from what is the case in classical physics …, also give expression to the irrational intervention of observation and its consequences as potentiality” (Laurikanean, 1985, p.208). Pauli himself continues:

> “On the one hand, the idea of complementarity that modern physics has demonstrated to us in a new kind of synthesis, that the contradiction in the application of old contrasting conceptions (such as particle and wave) is only apparent; on the other hand the employability of old alchemical ideas in the psychology of Jung points to a deeper unity of psychical and physical occurrences. To us, unlike Kepler and Fludd, the only acceptable point of view appears to be the one that recognizes *both* sides of reality-the quantitative and the qualitative, the physical and the psychical- as compatible with each other, and can embrace them simultaneously” (Pauli, 1952, p.208).

Pauli sought out an explanation for what he termed the *irrationality of reality* which would account for the observers relations to quantum measurements, made evident in the double slit experiment as well as in the thought experiment *Schrödinger’s cat* – which Schrödinger ironically developed to argue against the theory but which has become one of its most profound characteristics and lures. The cat paradox suggests, and proves mathematically, that a feline, in a nuclear experimental system, can be both alive and dead simultaneously in its pre-observed state. This is not a metaphor but refers to the phenomena of superposition and complementarity that we briefly encountered earlier.

Pauli was a pious man and abhorred the societal vacuum that opened in the 20th century as a result of what we've previously called the *Pythagorean hypothesis* at the root of the Galilean-Cartesian bifurcation. "Since the discovery of the quantum of action," he writes, "physics has gradually been forced to relinquish its proud claim to be able to understand, in principle, the *whole* world" (Pauli, 1952, p.209, original emphasis).

Pauli worked closely with Carl Jung later in his life on a speculative articulation of what the men termed 'the psycho-physical problem', and each were woefully adamant to call their own discipline's roots into account. "Thinkability is itself," writes Jung in *The Interpretation of Nature and the Psyche* (a collaborative book including writing from both Pauli and Jung), "an idea that needs the most rigorous criticism" (Jung, 1952, p.142).[30]

> "Whereas the scientific attitude seeks, on the basis of careful empiricism, to explain nature in her own terms, Hermetic philosophy had for its goal an explanation that included the psyche in a total description of nature. The empiricist tries, more or less successfully, to forget his archetypal explanatory principles, that is, the psychic premises that are a *sine qua non* of the cognitive process, or to repress them in the interest of 'scientific objectivity'. The Hermetic philosopher… was not yet so dominated by the object that he could ignore the palpable presence of psychic premises in the form of eternal ideas which he felt to be real. The empiric(ists)… hope was to be able to produce a picture of the world that was entirely independent of the observer. […] (A)s

[30] This quote in fact was borrowed to punctuate the video *A Borderline Conception* which this chapter is engaged in.

> the findings of modern physics show: the observer cannot be finally eliminated, which means that the psychic premises remain operative" (Jung, 1983, p.288-289)

What is clearly occurring between these two thinkers is a criticism of *Eurocentric thought, "*which produces a world of antagonistic oppositional principles related to each other only by hierarchical relations" (Okembi-RA, 2015). Pauli and Jung believed these oppositions, exclusions and bifurcations that limit and separate restricted our capacities and understandings of the world(s) of experience and affect, replacing wholeness with an epistemological masquerade.

To give some more insight into Pauli and the rationale in this chapter which addresses the question of 'scientific mastery' over nature and the human, I would like to recount the story about how he 'fixed' the atomic model due mainly, it is told, to his belief in the *irrational* alchemical tradition: The atomic model of Bohr, though revolutionary, was nonetheless not always living up to experimental observation – it had some serious flaws that no-one could seem to account for at the time and was proving to be quite complicated. First, in a letter to Bohr from 1924, Pauli was the first to introduce the idea to abandon exact kinematical motion in atoms (Laurikanean, 1985, p.157). Secondly, in the alchemical tradition of centuries previous, of which Pauli was rigorously invested, the so called *quaternion*, or the deeply rooted belief that nature cosmically operates fundamentally on holistic arrangements of *four* – for example the elements earth, wind, fire water; the cardinal points; the seasons; the four groups of three zodiacal signs, etc. – was one of the basic tenets of its practice and Hermetic knowledge (Laurikanean 1985). "It follows therefore that the division of a natural thing by the

number 4, *itself the order of nature itself*, is preferable to a division by 3 or 5, which are by nature derived from the root of the quaternary and consequently subordinated to it" wrote Robert Fludd in a 17th century response to Kepler. Fludd continues that, "a quadruple order constantly pervades the entire nature" (Robert Fludd's *Demonstratio quaedam analytica,* in the appendices to Pauli's *The Influence of Archetypal Ideas on Kepler's Theory,* 1952, p.230, my emphasis). The quaternion, witnessed in many alchemical symbols, not in the least the figure of the cross itself, premised Wolfgang Pauli's unshaken belief in this tenet that pushed him to realize that a fourth quantum number must be missing from the then triadic theory of Bohr's atomic model. Adding a 4th number, which would come to be known as *spin*, indeed stabilized and completed the model-theory, resulting in years of contentious atomic cultures we still struggle to deal with today; that mark the Anthropocene with a nuclear epithet, and that continue to decay into the deep future.

When in 1930 Pauli postulated the possibility of the theoretical neutral particle, the neutrino (a name given later by another Nobel physicist, Enrico Fermi), he half-jokingly wrote, "I have done a terrible thing, I have postulated a particle that can never be detected" (Sutton, 1992, p.xi), but it is no surprise that it was he specifically who opened the doorway to our understanding of our own ignorance of reality; that we do not understand 95% of matter and energy in the universe (the so called *Dark Sector*). Pauli's experiences of the indeterminate nature of quantum mechanics, as well as a deeply powerful dream life and a troubled social life, led him to seek out and eventually collaborate with the renowned psychologist Carl Jung. Like so many German writers, Pauli and Jung each, "asserted the value of feelings, subjectivity, and emotions against an idealization of reason" (Cambray, 2014, p.46). Both Jung and Pauli

believed in the *anima mundi*, or *world soul*, and each had researched the history of alchemy, its symbols and traditions - Jung in his study of archetypes, and Pauli in his study of mathematical and physics' origins. Crucially, Pauli was convinced from his understanding of quantum physics and his belief in the *ineffable*, that "the most important and extremely difficult task of our time (is) to work on the elaboration of a new idea of reality" (Pauli quoted in Laurikanean, p.228).

Pauli located the emergence of the formalized concept of *causality* or determinacy in the work of Johannes Kepler. This concept was to become the very nucleus of the new scientific method, premised as it was and is on *absolute causality:* the belief that, "all changes can be perfectly expressed according to mathematical laws, once all the causes behind something were investigated" (Ibid. p.46). Kepler was also a mystic whose work struggled with the tensions between phenomenal experience and the mathematical sciences. Kepler's *harmony of spheres,* for example, is premised on the belief that each of the planets has its own unique and individual souls (Pauli, 1952, p.156). What is clear in my own work, and in the work of these historical figures, are what Laurikanean describes as, "two apparently contradictory basic efforts – the struggle for mystical overall perspective and an adaptation of empirical sciences severe methods" (Laurikanean, 1985. P.122). On absolute causality Laurikanean continues, this "indirectly implies a denial of anything supernatural in the events of the material world […] This ended in a scientific religion— scientism—in which the conception of reality is limited only to matters which can be discovered by scientific methods" (Ibid.). It is through microphysics or quantum mechanics' *statistical* causality that a window opens onto characteristic indeterminism, which resists ordering into regularities.

In this analysis of Pauli's mystical rootedness, from the very man who proposed the neutrino particle, I want to stop and take notice, that while the characters discussed here are privileged white European males, in a dominant powerful discipline, they nonetheless go quite against the grain in their efforts to bring affect and irregularity back into experiences of nature, the self, and reality in an effort to conceive of a non-dualistic, 'nonmodern', wholistic nature. "It would be most satisfactory of all if *physis* and *psyche* could be seen as complimentary aspects of the same reality," Pauli concludes. The historian Laurikanean crucially reminds us that, "Pauli's strong emphasis on the irrationality of reality is essentially equivalent to Bohr's advocating of the idea of complementarity. Both express the fact that the events of the material world are not governed by an absolute causality" (Laurikanean, 1985, p.35). These realizations will have to inform the ongoing project of thinking the *Quantum Reformulation of Reality*.

In the following section I will address the bifurcation of 'culture' as a racialized concept and consider *oath-acts* as possible ways towards an ethic of response-ability (Haraway) a different or renewed ethic. The Anthropocene is a cultural as well as a geological phenomenon, which in many ways perpetuates the universalizing violence of 1492, by other means.

3.5 Ineffable Grammars

> "[E]veryone now knows that the climate question is at the heart of all geopolitical issues and that it is directly related to questions of injustice and inequality" (Latour, 2018, p.3)

> "Well, some worlds are built on a fault line of pain, held up with nightmares. Don't lament when those worlds fall. Rage that they were built doomed in the first place" (from *The Stone Sky, Broken Earth #3*. Jemisin, 2017).

This section is about a bifurcation of language, of grammar, and revisits the articulable / ineffable dialectic. By attending to these bifurcations, I am inventing ways of enunciating the ineffable (that which speaks but cannot be spoken) and the *intangible* (that which avoids classification and commodification). I am developing grammars for the "anti-colonial, holistic multidimensional thought" which I refer to as "the holographic" and the *Quantum Reformulation of Reality*. These metamodels are what give me the capacities and tools to undertake critical interdisciplinary work on the concept of Anthropocene and move towards an artistic inhabitation of the ineffable as source of resistance. Kathryn Yusoff makes the critical scope of the project explicit:

> "If the Anthropocene is viewed as a resurrection of the impulse to re-establish humanism in all its exclusionary terms of universality, then any critical theory that does not work with and alongside black and indigenous studies will fail to deliver any epochal shift at all" (Yusoff, 2018, p.18).

Whether we call it the *general movement* of Galileism, Cartesian dualism, the bifurcation of nature that separates quality from quantity and results in the *fungibility* (Hartman) of colored bodies, what matters now is to continually rethink, analyze, and call out

these *separations* – to challenge the self-reinforcing triad of coloniality, capitalism, and scientism. As Paul Rekret notes, "Any theory that wishes to confront the separation of the mental and material … must begin with a confrontation of how the compulsions to which capital submits social life organize that dualism. […] it will serve to our purposes of seeking to locate the 'separation' of thought and world, nature and culture, as a continuing site of social struggle" (Rekret, 2018, p.51-52). Capital, physics and geology are enmeshed within territories of exploitation. In my research I attend to these sciences to upset or counter their implicit assumptions of separation and categorization. To extrapolate these points I continue my reading of Federico Campagna's conceptualization of the *Technic cosmogony* through the *inhuman geography* of Kathryn Yusoff and the decolonial thought of Macarena Gomez-Barris.

Through a Marxist analysis of world religions' mystical traditions Federico Campagna describes an alternative cosmology he calls *Magic,* which is premised on the *Ineffable*, "That which cannot be captured by language in any form" (Campagna, 2018, p.121). That which escapes languages capture does not have to simply perish in a world dominated by finance and scientism but can become a force of resistance towards those antagonistic regimes where the very, "notion of responsibility doesn't make sense" (or cents), where only a deeply flawed idea of 'progress' and individualism drives. According to Campagna, the cosmogony of *Magic* challenges, "the very metaphysical foundations on which our world currently rests", and so could contribute to our thinking of scientific cosmology (Campagna, 2018, p.89). The alter-cosmology of *Magic* described by Campagna, reminds us that there is something about nature which is incalculable, indescribable. In his description of the *Technic* cosmogony (which he takes as responsible for the so called 'collapse of reality'), we witness and understand sets of

ruthless practices, epistemologies, ontologies and ethics that have led to our contemporary condition in the context of capitalisms insatiable greed.

The *ineffable* resonates through Macarena Gómez-Barris' articulation of the *intangible* found in her book, *The Extractive Zone: Social ecologies and decolonial perspectives* (2017). In the first chapter titled *The intangibility of the Yasuni*, Gómez-Barris writes: "[I]ntangibility names for me the capacity of life otherwise to reroute itself around commodification and scientific classification."(Gomez-Barris, 2017, p.18). Again, we are witnessing, though now through an Andean phenomenology, a gesture from beyond that which is speakable, that is inherently directed around domination by economic power. On Andean phenomenology that is at the core of her research with Indigenous communities and artists, she writes,

> "[It] starts from another vantage point: it locates the subject in multirelational terms and blurs the binary distinctions between the human and biomatter into porous interactivity. The self is not bifurcated between an inside and an outside, and thus there is no simple divide into distinct formulations of the external other; instead the self embraces (and is embraced by) a sensual and integrated relationality with the natural elements and everything that surrounds us" (Gomez-Barris, 2017, p.41).

To further the reach of the concept, she continues how this philosophy extended into, "The idea of *el buen vivir,* translated as good living,", a concept which was appropriated by the neoliberal government of Ecuador, but that initially, "decenters the importance of the 'human being' by focussing instead upon how the natural world possesses its own sets of rights, logics,

and capacities that cannot be solely apprehended, managed, or narrated through human language or scientific technique" (Ibid. p.23). In Gomez-Barris' work the *intangible* of the Yasuni tribe of the Amazon is aligning an agential realism or posthumanism that counters bifurcated metaphysics towards a decolonial ecological praxis that offers, "a viable future for interacting with the natural world rather than merely ransacking it" (Ibid. p.38). Crucially, Gomez Barris writes, "Andean phenomenology is…. A way of being that disentangles from the discreteness of the 'Global North' psyche and also from the artificial separation of life into organic, inorganic, mobile, immobile, animate and inanimate matter" (Ibid. p.41).

Between the ineffable of Campagna and the intangible of the Yasuni via Gomez-Barris, we move into territories of affect and emotion, of felt and situated knowledges; we move towards, what Gomez-Barris calls, "the poeisis of difference, the untaming of the other, refusals and reversals". (Ibid. p.134). This category of the irreducible, for Gomez-Barris, "reassigns meaning away from the devaluing of life at the core of capitalism" (137). It might be generative to think these refusals in the context of an unbound human-environment relationship, social contracts with the earth grounded in a politics of climate breakdown. These oath-act's that reach into the ineffable and intangible as both experience and experienced however might not resonate with readers who, with Barris and other decolonial scholars, question, "[I]s spirituality too bound up with the religious colonial order to imagine an outside?" (Ibid. 61). With the intangible and the ineffable, with what cannot be counted, with what remains *opaque* (Glissant), hidden from the colonial processes of categorization, we begin to arrive at something of an inverse to the dominant hegemonic power structures that define

so many traits and behaviours, so many scales and orders of subjectivities, personal and institutional.

> "[T]he need persists to find paradigms that acknowledge colonial legacies, elaborate on contemporary notions of power, and insist on other realms of experience beyond the material. If we understand the current rationale that reduces relationality to the legacies of colonialism, and that permeates the affective and relational deficit of the current period – what we can call the 'melancholies of late capitalism' – then we might be able to move toward a more complex sense of what decolonized spirituality looks and feels like" (Ibid. 61).

With Gomez-Barris, Wynter and Yusoff we can begin to critically regard these highly contentious and necessary practices of 'rethinking' the multirelationality of humanness, agency, and the 'natural world' that this chapter embraces and analyses from a variety of diverse perspectives, from western and non-western epistemologies. What is at stake here is the multiplicity of life itself, freedom for thought, the proliferation of knowledge that we will need to reverse the worst of climate atrocity, injustice, and mass extinction trajectories.

Absolutist monistic logics don't serve a purpose if we are to be relevantly attending to climate, ecology, and environment and to the injustices that proliferate in and around them. But the world of finance, or the cosmology that it imposes, restricts *the paradox*, the reciprocity of any complimentary continuum, a reciprocity that also occurs quite explicitly in observations from quantum mechanics. Quantum mechanics is not, however, a coherent

theory of nature - it does nonetheless have quite profound tips for us, tips for helping us to think *continuums* in relevant ways, ways that disclose the irrationality of reason. This is why Birgit Maya Kaiser and Kathrin Thiele, in the special issue of the Parallax Journal on *diffraction* refer to "the quantum reformulation of ontology" (Thiele & Kaiser, 2016). This reformulation must however incorporate decolonial, holistic multidimensional thought, which I develop here in the continuities of holography. This means coming to terms with some of the implications of quantum observations and thinking along with Black Quantum Futurisms – observations that some argue call for a complete undoing of the Cartesian foundations of science and race, of unhelpful splits between subject and object.[31]

In Lake Baikal live the Buryat people, whose ecstatic leader-healers known to them as *buge* were systematically killed by Tsarist, and later Stalinist regimes since the 16th century. "The origin of the term Shaman: the ecstatic one," writes Margaret Stutley (2002) "is still disputed but can be traced through many cultures terms meaning to apply heat and potential power – the term was first discovered by Europeans through the Tungus, and so that term is still used, though in various cultures the term is different" (p.4) The very term shaman comes from Siberia. Stutley (2002) writes, that "despite cultural differences three things are shared by all forms of shamanism: (1) belief in the existence of a world of spirits, … The shaman is required to control or cooperate with these good and bad spirits for the benefit of [their] community. (2) The inducing of trances through singing, dancing, and drumming when the shamans spirit leaves his or her body and enters the supernatural world. (3) The shaman [is a

[31] Please see the essay of Markus Appleby *Mind and Matter: A Critique of Cartesian Thinking*, in the edited volume "The Pauli-Jung Conjecture and Its Impact Today", Atmanspacher, H. and Fuchs, C. eds. Imprint Academic: Exeter (2014)

healer]. (p.2) Although many Indigenous people do not have a word meaning *supernatural*, since *nature* or reality is simply already more-than what westerners narrowly allow themselves to perceive of it. I suppose, in some ways I imagine myself and other artists, musicians, and filmmakers operating in the terrain of the alchemist, the shaman, the storyteller, the scientist, the holographer – all heuristic ways of learning from and intervening in the environments around us. Finally, shamanism is not a centrally ordered religion but specific to place, tribe, and ancestry. "Krader (1956) has pointed out that shamanism", continues Stutley, "can be used in various ways since it is an element in all religions, such as in the charismatic leaders of Buddhist, Jewish, Islamic, and Christian and other cults and sects… Similarly Voight (1977) claims that the origins of most religions can be explained completely by shamanistic analogies" (p3).

To close off this chapter then I'd like to leave off in the words of a world renown Indigenous Yanomami shaman and leader Davi Kopenawa,

> "For any dialogue to take place, it is necessary to respect cultures and understand the immense variety of long histories of thought in different contexts. A purely technical rationality without conscience or spirituality, dominated by material interests, leads the industrialized world to the destruction of our planet." (Jean Malaurie, Introduction to *The Falling Sky.* Albert & Kopenawa, 2013)

Chapter 4

Viriditas (In The Future Perfect)

22. *Viriditas: In the Future Perfect* (Still). 2019-2020.

Link to Media:

https://vimeo.com/372626442

P/W: viridita5

> “The secret / of this world is an enigma that knowledge alone will never solve”
>
> (Hafez, 2008 Quoted and translated in Campagna, 2019. P.201)

> “Science in every form is a story of the world” (Cajete, 2004, p.50)

Viriditas (2019) is an incantation of colour, image, sound and voice that summons a non-linear, *epi-phenomenal* (Wright, 2018, np) timespace, entangling western alchemical and animist histories with contemporary theoretical fusion energy. Current research in experimental fusion reactors, and its more than 70-year history of repeated failure, suggests that this 'clean', water fueled nuclear energy will always remain thirty years away, *in the future perfect*. This futuristic fusion technology attempts to build and magnetically contain a star on Earth as an 'unlimited' energy source. The quest to harness the power of the stars however has a history going far back to the origins of human civilizations. In this performance-lecture turned video I conjure the premodern relational tendencies inherent to an often-disregarded European ancestry - the quite surreal alchemical tradition - to question the history and tenacity of Modernity's practices of extraction, exploitation, separation, and desacralization of nature. As the video elaborates, *Viriditas* "is also a word that means vitality, fecundity, lushness, verdure, or growth. A *greenness* particularly associated with abbess *Hildegard von Bingen*… the 12th century polymath who used the term to refer to or symbolize spiritual and physical health". Viriditas then is a development of my fascination with the complex and overlooked relationships between physics, epistemic violence, and environmental stewardship - a progression in my practice made explicit and traceable through processes of (re)situating physics in space and time, retelling its stories in relation to ecologies and histories. *Please proceed to watch the video.*

"Poetic knowledge is born in the great silence of scientific knowledge"

(Césaire, 1978, p.157)

"If art can change the world, it is by transforming the way we perceive and live in it"

(Saraceno, 2020, np)

4.1 Unsettling Physics Environments

As a result of my ongoing research-practice into the situated, environmental, and expanded notion of physics' *landscape-laboratories* I came into contact with the sound artist Julian Weaver in 2018. After some initial conversations we agreed to collaborate and made some initial research after a visit to the Culham Centre for Fusion Energy (CCFE) in October 2018. We applied for and were awarded a commission by the *Centre for the GeoHumanities* at Royal Holloway University in London. The commission, funded by a multiyear project entitled *Creating Earth Futures*, forms part of Dr Harriet Hawkins' Arts and Humanities Leadership Fellowship grant, and explores GeoHumanities approaches to global environmental change.[32]

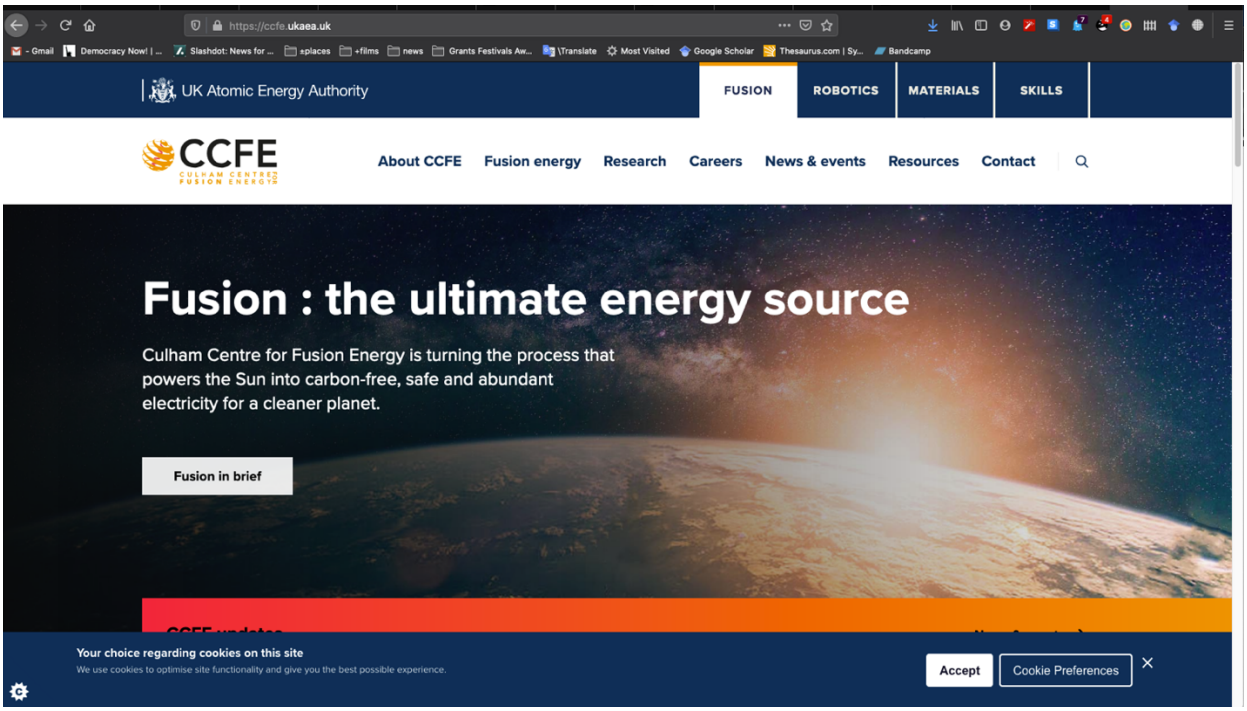
Our project initially proposed a polyvalent understanding of what fusion energy, a theoretically clean and unlimited nuclear energy source, could mean for the future global environment and economy. We proposed to achieve this through ethnographic interviews which would help us, and others, to understand the culture and potential of plasma and fusion

[32] See: http://geohumanitiesforum.org/geohumanities-commissions-2018-creating-earth-futures/ and http://harriet-hawkins.bisonbison.co.uk/creating-earth-futures-ahrc-leadership-fellowship/

physics on global energy infrastructure and, thereby, geopolitics. The interviews, and the expanded site of the CCFE, was documented using video and sound recordings. We had proposed that these a/v materials would then be assembled for a future exhibition and as reference documentation for a printed publication. Our aims were to better understand the material, and physical limits of fusion and its implications in terms of environment and energy landscapes; to look at how these issues influence broader institutions, and how these meanings might resonate with other conceptualizations of 'cleanliness' in the environment.

We conducted research around the nuclear ecologies of plasma physics and fusion endeavors using a variety of creative research methodologies that allow for a range of approaches to the practices of fusion experimentations, the sites on which they take place and their connections with the surrounding landscape and structure. As artists and researchers, our methods and approaches are of course quite different from those of the physical sciences. Our contention was that an openness to possibility, allowing for emergent thematic development over the course of the visits to CCFE, would allow us enough flexibility to adapt to the knowledge we gained as we proceeded. We had begun reading popular science books telling the 20th century histories of physicists failed and fraudulent attempts at attaining this theoretical clean energy method as means to begin discussions with scientists and engineers. I refer to 'fraudulent' attempts because the political possibility of infinite energy during the cold war left some scientists and governments making spectacular claims in Argentina. In 1949 the Austrian physicist Ronald Richter was given an island off the coast of Patagonia for the Huemel Project's 'Thermotron' which was claimed successful by both Richter and by the Argentine president Juan Perón in 1951 on the international stage, though subsequent investigations

showed that the project was ultimately and equivocally unsuccessful, Richter himself being charged with fraud in 1955 after the cancellation of the project and the ousting or Perón.



23. A screen shot showing some claims made by the CCFE/UKAEA on their website: 'turning the process that powers the Sun into carbon-free, safe and abundant electricity for a cleaner planet'.

Julian and I proposed to experiment with a hybrid of *para-ethnographic*[33] and *'pataphysical*[34] methods to produce an artistic elaboration of the implications of a fusion future and the quixotic quest to attain it. In doing so, we had hoped to explore the role and character of artistic research in the production of knowledge between arts and sciences and the

[33] Collaborations among anthropologists and "other sorts of experts with shared, discovered, and negotiated critical sensibilities". As mentioned previously, for me, however, para-ethnography as an artists tool has to do with the experimental spirit, and spending time with (as a form of 'interview) ones materials.

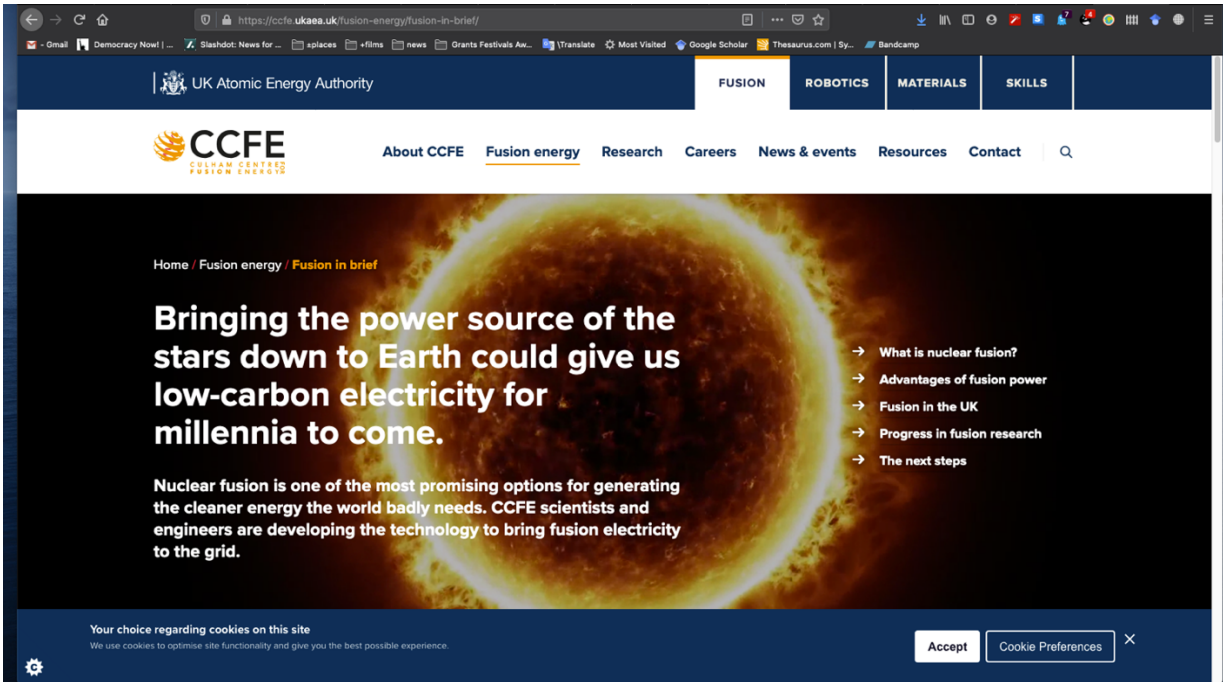
[34] The science of that which is superinduced upon metaphysics. 'Pataphysics has been referred to as the science of 'imaginary solutions'.

possibilities of its implications for, or additions to, the field of GeoHumanities, while at the same time encouraging a forum for fusion energy and plasma physics research outside of its traditional sphere of engagement.

Our primary investigations were to explore the full CCFE video archive, to make audio and video recordings internal and external to the research center, and to conduct ethnographic interviews with CCFE staff. Something perhaps particular to UK scientific institutions however made our research quite difficult if not stifled, which I would refer to as a rigorous arts skepticism, and so halfway through this difficult investigation and constant deferrals we decided to reach out to other research facilities in Europe, the largest being the International Thermonuclear Energy Research facility (ITER) in southern France who responded kindly and invited us to explore their facilities and construction site in August of 2018.

For our secondary investigations we had planned to undertake a *media ecological* investigation of key elements (e.g. lithium, deuterium, tritium, beryllium), resources used and required in the fusion process. As Yuriko Furuhata (2019, np) makes clear, “we cannot dissociate the political economy of mineral extraction and warfare from the historically and locally situated knowledges and techniques of elemental control”. At the CCFE, this became quite apparent, as they produce on site the element tritium, which can be used for both nuclear weapons and plasma energy experiments. Due to this tritium breeding ground on site, they also have a strong military presence, as well as their own police force. The media ecological research which focuses on networks of extraction and production of elements and minerals used in the physics landscape both aimed to build a resource chain overview, helping to map out the feasibility of the claims made by the sector, but also contributed to our onsite

para-ethnographic work – where, for example, one might 'interview' or spend considerable time in the presence of a specific element, object or material, remaining attentive to non-cognitive resonances from the materials, a hypersensitivity to impressions or communications emerging from them. We also explored the research center in an expanded context, namely its conceptual, physical and infrastructural relationships with utilities and the landscape. This included investigating nearby waterways, the Wittenham Clumps nature reserve, and the nearby power stations of Didcot & Harwell, which in the time of our research had still standing cooling towers. We also reviewed literature from the field of plasma physics and fusion reactors with expectations that this local and historical engagement will help to define a trajectory and genealogy in the ongoing struggle for this supposedly abundant and clean energy. While this research did contribute to some written work that has been posted on the GeoHumanities Forum and ITER website, after some time, other interests in the narrativity and allegorical positioning of these experimental assemblage's took our interest. At the time that it was necessary to bring our various strands of research together, Julian became dangerously ill and was unable to communicate with me for a presentation to be made at Raven Row with the other Creative Commissions artists and the Centre for GeoHumanities. It was in that time that I changed gears and trajectory and produced the poetic performance lecture text and image presentation for a performance lecture.



24. A screen shot showing some claims made by the CCFE/UKAEA on their website: 'electricity for millenia to come' & 'one of the most promising options for …cleaner energy'.

4.2 Encountering Scientific Skepticism

The CCFE has two experimental types of fusion reactors, the older *MAST* (Mega Ampere Spherical Tokamak) and the younger sibling of ITER, JET (Joint European Tokamak). MAST and JET are different by design, as there are a number of theoretical ways to design the best plasma containment vessels. One shape is more spherical and the other more toroidal (doughnut) in shape. Due to the experimental and precarious nature of this research we were only granted permission to visit when the facilities were in shutdown mode, specifically for recalibration and restoration. Indeed, it proved difficult to find an operating research reactor that we could engage with firsthand. In my years of art-science investigations and fieldwork, I have rarely encountered such a high-level of consternation about our practices and involvements on site. CCFE's reluctance eventually led us to contact and visit ITER. CCFE made it difficult for us to be in touch with scientists and chose rather to direct and curate our visits by their standards.

Although we were happy, and perhaps lucky to visit the site at all, we none the less felt less like interlocutors, and more like burdens. They were quite protective with their archives - we never managed to view their video archive for example, though they did share some .gif and .mp4 files with us which made it into *Viriditas*. Their control over the images functioned as a bottleneck, where the institution dictated what we as artists could show and directed what they thought was interesting, over-riding our very profession, our role in determining what was interesting or aesthetically alluring. A frustration with this control led me to become more and more critical of their practices and more willing and open to express that. My previous experiences of openness and willingness to relate and share within scientific paradigms may have been a historical combination of luck and/in having had been invited to institutions by the most senior management who granted me more or less free reign to do what I thought was relevant and offering any support that they thought I might need or appreciate. In the case of CCFE, Julian was mediating contact with them through an acquaintance who works there from the 'VTT Technical Research Centre' of Finland. That acquaintance had put Julian in contact with the CCFE media manager who oversaw and guided all of our visitations. The manager was not the most responsive or receptive to our requests to visit, emails sparsely answered, and meetings consistently deferred. This was partly due to the precarious and experimental nature of the work they are doing at CCFE and due to the high levels of security around the site due to their production of the heavy radioactive element *tritium*, which they use for fuel and which is derived from H20 and beryllium.[35]

[35] The 'ease' with which scientific institutes and political actors could then disperse these 'clean' (meaning 'safe') technologies into the world are actually fraught with high level security risks that undermine the communication rhetoric of fusion energy as clean, safe and for 'humanity', when undoubtedly these infrastructures would be available for Northern weaponized countries foremost.

The history of nuclear research is of course deeply implicated in the militarization of physics, science and technology. The very nature of the types of nuclear *fission* (not fusion) reactors that are operating around the world are designed such that their fuels can be easily incorporated into weapons. In this sense, the dispersal of particular designs of nuclear reactors can be construed as artillery factories. That is to say that there were and still remain other options for less dangerous and more efficient reactors. Yet, because they do not supply the military with weapons-grade plutonium, they're not considered an option for the energy infrastructure of states.

CCFE was meant to return to operations after years of restoration in the summer of 2018, but due to a mechanical failure in a test running up to this ignition, it was again postponed. It was made apparent to us that the media manager didn't want us there in this tense and busy time. It was then that Julian and I decided to reach out to the international megaproject known as ITER, the 'big brother' of the JET experiment at CCFE located outside of Marseille, France - in a village at the northwestern tip of Aix-en-Provence: St. Paul-lez-Durance. ITER were surprisingly very welcoming, though our time on the site was about 6 hours and we were really quite rapidly toured through the various sites, we were nonetheless somehow celebrated visitors there, and they published a blog post about our visit on their webpage (https://www.iter.org/newsline/-/3072).

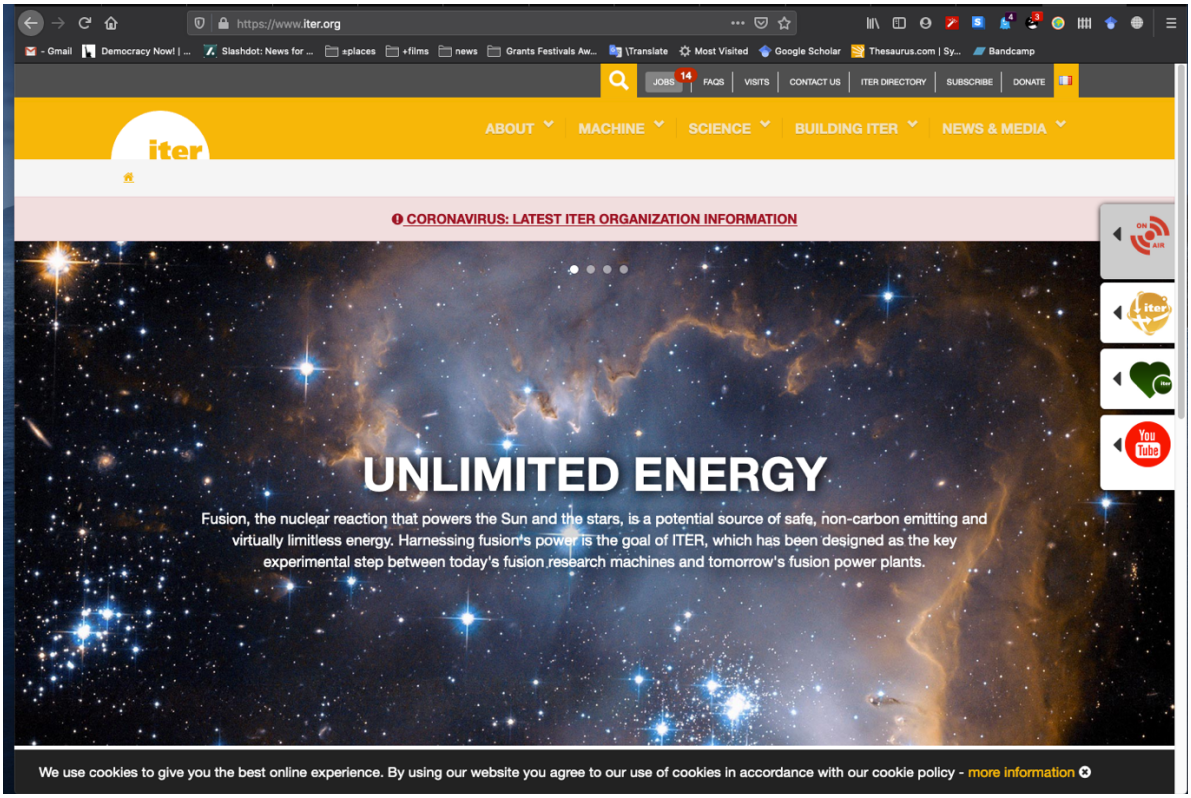
4.3 What makes for a good art-science collaboration?

Before moving on to speak to our experiences of ITER and explanations of the site and its contexts, this narrative will speak to the challenges we faced as artists entering into

epistemic territory that is highly controlled and regimented. I'd like to refer to a recent article in Nature magazine, forwarded to me by Dr. Elisa Resconi of the TüM collaboration about art-science collaborations from the perspective of artists and curators.[36] The 'career-feature' article, 'How to shape a productive scientist–artist collaboration" (Gewin, 2021) interviewed Yunchul Kim, Fernanda Oyarzún, Muzlifa Haniffa, Aoife van Linden Tol, Xin Liu, and Abrian Curington about their experiences and expectations. One of the most significant refrains that came through this article, and to which I wholeheartedly agree, is the necessity for mutual respect. "A partnership has to start with trust and respect," writes Oyarzún, a 'scientific sculptor' and marine biologist. "Each person needs to be humble about what they know" she continues, "The overarching goal is the process of creating something new together — and the resulting exchange and reshaping of ideas… There is no way someone is going to collaborate with you if you are standing above them." (np) This mutual respect, this humbleness with what is known means operating with epistemic freedom, a willingness to encounter other ways of seeing, knowing, feeling, and observing the world. Without this non-hierarchical attitude, projects - as in my own case - have been thwarted. Artist Aoife van Linden Tol responded similarly: "The most common misconception that scientists have about artists is that they are chaotic or are simply illustrators helping to educate the public about science. What gets lost is the deeper meaning that the artists could give to scientists. Artists are trained to educate themselves on a variety of topics so that they can offer critiques on life, society and politics, and those skills are transferable to science." Here, Linden Tol gets to the heart of what some

[36] Prof. Resconi is an exemplary commitment to good art-science relationships and collaborations. It is with her that I have been able to develop lasting relationships and conversations, and new art-science engagements and artworks. More on this in the conclusion.

scientists prefigure about art and artists, what leads to their misunderstanding artists and perhaps considering themselves or their knowledge more important or more 'true'. And while there is of course precedence and contexts and situations where certain forms of knowledge is more applicable or valuable, that does not render any one form of knowledge universally, hegemonically valid. The issue is made clear with climate change and the need for story, worldmaking, world-building practices; for a form of radical collaboration across disciplines, epistemologies, and cosmologies.



25. A screen shot showing some claims made by the ITER consortium on their website

4.4 Fusion problems

The project of fusion is a truly globalized project. Sites, institutions, experiments, and facilities around the world struggle and share resources at an almost unprecedented rate. The

complexity of generating plasma, getting it to remain in a self-sustained burn, and containing all of this with extremely strong magnetic shields that need to be super-cooled, is a *wicked problem.* They are essentially building a series of miniature stars on Earth and attempting to contain and harness their heat for mechanical energy – a sort of down-to-earth, terrestrial constellation of miniature stars. Plasma is the fourth phase of an element, following liquid, solid, and gas. There are other phases for elements that occur that we know about, but they only occur in very unique high pressure or temperature extremes that occur far outside of our local spacetime. Plasma is typically reached at temperatures exceeding 100 Million degrees centigrade, for example in stars and in lightening. The temperatures and the phenomena are intense, to say the least, and these events scorch any materials that are anywhere near to them. The project of experimental fusion reactors therefore is also a significant materials science challenge. The most inner shielding between all of the machinery of a fusion reactor assemblage and the actual burning hydrogen plasma needs to be extremely versatile and strong – any small perturbation in the plasma that touches these inner walls can destroy the equipment, requiring months or years of refurbishment. The containment of the plasma is then one of the most difficult of the problems in reaching fusion as a viable energy source. Institutions in Japan, Korea, Canada, the US, Europe, Russia, China, India, Pakistan, & Brazil, all work on different elements of this containment. Of all the experimental nuclear fusion reactors on the planet that are publicly funded, all of their research is essentially being funneled up to the ITER project, which will be the world's largest experimental Fusion reactor, with first sustained ignition expected in 2040. ITER, it is hoped, will demonstrate that the technology is feasible, and if or when successful, a third-generation reactor named DEMO, operable in

perhaps 2070 (likely later), will actually create more energy than is put into it, and distribute that energy out into the grid. Fusion's long timescales unique to the sector later became one of the key conceptual driving factors for situating these experiments in broader historical context.

Speaking with some engineers on site at ITER we learned about some of the difficulties in its international networks operations, not just between languages and general understandings, but involving fundamental discrepancies in how things are built, which ways screws ought to turn, production qualities and precision standards, how something ought to be welded, etc. Each country that contributes funding to ITER essentially has at least one smaller national facility where they experiment, test and produce parts. Different work ethics in different parts of the world, meaning the durations in which things take to be built also differ, and so the timing of essential pieces to the complex matryoshka doll that is the ITER assemblage is very complicated and requires significant management skills. A previous director's mismanagement had set the project back a decade before a new manager was hired and is now getting the project slowly back on track. On top of all of this, the scale of ITER is unprecedented, meaning that most of its essential pieces, like the super cooled magnets, or the cryostat, the thermal shield, the vacuum vessel, or the bearings that rotate any of these pieces – all of these are the largest objects of their kind ever made in the history of their production, many of them requiring new techniques of construction and shipping; even the mobility on site for installation proves to be a complex logistical puzzle requiring special bespoke equipment and vehicles.

From a critical perspective, these nuclear fusion sites of experimental plasma reactors that do not produce radioactive waste that last thousands of years (rather only a hundred years

and in much smaller amounts) nonetheless still operate on the capitalist/colonial logic of the concentration of power, centralizing energy from a complex hierarchy of academic, scientific and technological prowess. One question here remains: why spend billions and billions of dollars on clean energy infrastructure that may not ever function in any substantial way and not incorporate that money into building clean energy infrastructures now that we know to work and that can decentralize energy infrastructure making it more resilient for the catastrophic world of climate destruction that we have tipped into? The militarity of 'clean' energy production experiments is obfuscated by their claims of solar appropriation, rendering their work cosmic and perhaps even suggesting a certain divinity. These allegorical tropes will be discussed in the next section. This current line of consideration highlights the implicit geopolitical factors that the sites and reactors participate in. Even if it were possible to maximize working fusion energy reactors and to distribute them globally, this dispersal operates in a colonial logic of 'improvement' and necessitates entire educational infrastructures, furthering the Western educational and scientific canon and systems into all corners of the world.

4.5 An Evolving Practice: 'Black Women Physicists In the Wake'

> "Westerners must learn how to make ourselves fit, and to be perceived to be fit, to enter into the democratic, pluricentric global dialogues from which global futures will emerge." (Harding, 1994, p.5)

> "Will we be able to invent different modes of measuring that might open up the possibility of a different aesthetics, a different politics of inhabiting the Earth, of repairing and sharing the planet?" (Mbembe, 2019, np)

It could be helpful to remind the reader that I did not enter into my PhD understanding what exactly I was searching for in meta/physics, nor how precisely I would pursue it - but that I would be open to experience and theory, developing an artistic methodology, concepts and practices, through fieldwork, research, reflection, and of course *diffraction.* This is the experimental spirit we encountered in the introduction, essential to my methodology and its capacity to be fluid and adaptive to new encounters and phenomena as they arise. What has occurred over the course of my studies has been a significant reorientation or supplementation of my initial metaphysical critiques of nature, technology and cosmos in the age of Anthropocene, to engage more with decolonial practice, methodologies, and to pursue this decolonial *option* (Mignolo & Walsh, 2018; Mignolo & Vázquez, 2013). Through a better engagement and understanding of decoloniality, and the 'colonial matrix of power' (Mignolo & Walsh, 2018) through readings in the black radical tradition. Collaborating with a group of black feminist and Afrofuturist artists it has become more and more apparent to me over the course of this research that the spaces within which I operate are blindingly lacking of people of color. I have also observed the roles that these powerful sites and disciplines have played historically in classifying and excluding. Aside from one encounter at ITER, at no other time in my fieldwork did I meet any scientists, researchers or managers that were not White. This is especially true in the European context, while less so in Canada. If indeed, 'a new science is possible', this

remains an incredible hurdle for physics as a discipline and trajectory and something that has begun to be a more substantial question in my current, ongoing projects that are not yet mentioned in this dissertation. As a critical researcher, a white settler, read as cis-gender male who identifies as non-binary, it has become quite apparent that I have an ethical duty to draw attention to and discuss these issues with the people and scientists I meet, and whose laboratories and practices I am invited into to make work. In Canada, for example, I address my own settler coloniality in a physics site that is also on indigenous territory which, in turn, is also the site of the largest mining community on the planet – in the Sudbury Basin. Discussing regularly with scientists and science communicators of the McDonald Institute, a Nobel prize winning laboratory, my own voicings and concerns have begun to become more and more taken up and discussed within these circles, which are very interested in queer and decolonial work. However, I would like to be able to continue to work in those spaces in some regard so that the rare and difficult work of queering and decolonizing them can continue and grow. I firmly believe that art and culture can more directly inform and influence scientific understanding and description if we're allowed inside, are able to communicate, and are respected for our own forms of knowing and meaning making.

Since I have yet to encounter any non-white scientists in the field over the course of years of research and fieldwork, I have researched the lack of representation in one of the most powerful disciplines of Western cosmology. I have come to admire the highly regarded African American feminist physicist Chanda Prescod-Weinstein who also writes about 'using science against science' – against the flaws and pitfalls and racisms inherent to the sciences and their troubled histories (2017). Prescod-Weinstein is the sole black female theoretical

cosmologist in North America. She has won a number of awards for her activist and diversity work in physics, for example the 2017 LGBT+ Physicists Acknowledgement of Excellence Award "For Years of Dedicated Effort in Changing Physics Culture to be More Inclusive and Understanding Toward All Marginalized Peoples."[37] In her column 'Black Women Physicists In The Wake' (the title of which is a reference to Christina Sharpe's crucial and influential 2016 book *In the Wake: On Blackness and Being*) she writes, "In the wake, science is a tool of oppression, the way the boat is better designed, the way pure astronomy is funded to help make distance measurements between the Gold Coast and the West Indies more accurate…" (2017b, np). The role of the sciences, including optics, physics, astronomy, and navigation within the past 500 year history of coloniality needs to be further addressed and elucidated if we are to develop a more robust and meaningful science. As my projects have developed over the course of my dissertation, this has become an important task: contributing to a critical situating of the sciences in the colonial matrix of power as a practice intent on a better, plurivocal science.

Speaking specifically about teaching physics to BIPOC students, Prescod-Weinstein, echoing Adrienne Rich continues, "this is the oppressor's language, yet I need it to talk to you." We all need it to speak to students because it's a powerful language that carries authority in the world, and we have to (re)distribute that power to those who have been historically excluded. Traditionally the sciences have had the power to cut through religious zealotry and right-wing fascisms that manipulate, spread hate and continue to exploit people and degrade land and environment. There is of course a desire for all people to have the abilities to practice

[37] See: http://lgbtphysicists.org/excellence.html

sciences, and to understand how and why they are valuable, and in what contexts. Over the course of the last decades, and brought into stark relief in the last years, is the extent to which the sciences have come upon extreme skepticism by right-wing, neoliberal, religious and capitalist exploiters. A necessary contribution towards building a resilient and just world, is a science that is ethical, situated, and postcolonial – meaning that it no longer supports or contributes to white supremacy, imperialism or other racist social structures. The complicity of sciences in the troubled histories and contemporaneity's of the present still need to be addressed. A part of this research's' critical edge is found in its exploration of *another science* – one that is intimate, that doesn't presume to have the first and last word on reality, matter, or meaningfulness, and one that empowers and improves more of the world for more of its inhabitants.

"When the mattering only serves the discipline as it is, and not the people at the margins of the discipline, what are the implications for the relationship between the people and the discipline? Whom does the discipline serve?" asks Prescod-Weinstein (2017a, np). In her paper 'The Self-Construction of Black Women Physicists', she writes "It is in the context of an intersectional feminist standpoint that we begin to understand the severe limitations inherent to the Euro-American physics community's traditional self-construction" (2017a, np).

How will the sciences, and physics in particular work to relieve these limitations? The work that I have shown in this dissertation contributes to this important work of *rupturing,* using the best parts of science against its worst. In line with feminist decolonial practice this means, to begin with, bringing underrepresented voices and thoughts into the spaces of physics while doing fieldwork, challenging the canon and normativity of the spaces and

backgrounds, and asking questions about implicit exclusions - delinking from the superiority complexes of the disciplines androcentrism; troubling the boundaries of the laboratory to complicate agencies in the lab, focusing on the plurivocal other-than-human 'geontologies' which contribute to a fundamental reorientation of concern as to what matters or is meaningful in/or about the lab (this is both a historical and environmental practice of situating which can also consider resource extraction and population exploitation); playing sciences histories against their self-professed objectivities, linearities and narratives of cultural exceptionalism, situating claims of universality historically to transform their validity (Mignolo & Vazquez 2014) – as Glissant notes, *"a generalizing universal is always ethnocentric"* (117); using the strangeness of quantum theory to continually undermine the structures of epistemic violence that the field participates in of which Karen Barad and Denise Ferreira da Silva so brilliantly describe and practice. What this chapter also considers is the notion of 'counterallegory' described by Elizabeth DeLoughrey in her 'Allegories of the Anthropocene' (2019), troubling the often obfuscating claims of an experiment or fields particular narrativization. This is discussed further on in the chapter. All of these approaches work to challenge the structural problems within physics' discipline, their historical anti-blackness, their claims to universal validity, exceptionalism and 'triumphalism' (Harding 1991; 2008) that degrades other modes of knowing, sensing, feeling and being so that a richer, fuller, pluralistic cosmology might grow in tandem with socially constructed objective truth claims that can attend to a fuller spectrum of human experience and desires. Revealing the coloniality of the discipline, their policing of reality, language, and "how they've functioned to erase, silence, denigrate other ways of understanding to the world" (Mignolo & Vazquez, 2014) is what is

necessary for a new vibrant field of sciences that supports *planetarity* (Spivak, 2003) and *earthly multitudes* (Clark & Szerszynski, 2020). Prescod Weinstein writes "I've always been interested in how science is contextualized in society and the question of doing ethical science… always ties back to: *what has science been in the past?* and what can we learn about how science has been *so that we can better understand what science should be*?" (2017a, np).

As my research developed, and in resonance with Prescod Weinstein, the video-lecture *Viriditas* included with this chapter also explores some of the complex histories, the genealogical roots of science in the vibrant alchemical tradition. Here a situating practice is also crucially temporal as well as socio-cultural. As in previous works I've done the poetics of displacing objects or events in time with contemporary practices helps to also ground some of the claims being made within rooted histories that may be preferred to be forgotten, if not intentionally written out of the story. "Science transforms its languages; poetry invents its tongues" writes Glissant (1997, p.85). Poetry does this, for example, by challenging notions of linear time and gesturing towards indeterminacy as an ontological force. Poetry can also reorient understandings of who or what speaks, thereby opening onto worlds beyond the exclusionary 'absolutes' of mathematics and equation, into the more-than-human. Thinking briefly with Chantel Mouffe, we can call this "a process involving a multiplicity of ruptures" (Mouffe cited in Hall, 2017, np). The poetic ruptures that will bring forth better science and a better understanding of what sciences are, are here argued as being queer, feminist, decolonial and devoutly antiracist – we might call this bringing the sciences into a *poetics of Relation* (Glissant, 1997). This means the sciences and the educational paradigms that support them need to become quickly and effectively more inclusive to Black, Indigenous, People of Color

and the LGBTQ2S+ communities. This also means that the field needs to do the work of publicly facing the histories of exclusion and the reality of the exploitations of minority ethnic groups that have been exacerbated by technologies and philosophies emerging out of the sciences and discussing how these disciplines plan to do better in the future. This is obviously a tall order to some, and we're seeing the rise of anti-racism today spreading, finally, quite quickly through many layers of society after the police murders of George Floyd, Ahmed Arbery and Breonna Taylor in the pandemic summer of 2020 USA. But if we desire a society or world that will function better for more people, this essential work that needs to be done in the sciences that underpin so much of contemporary society should be understood as a basic principle towards that goal. Artist-allies acting in solidarity can have an important role in bringing and bridging these discussions in arenas that have had little experience with these topics. If we want communities to trust in science, and therefore to make better decisions in light of, for example, climate change, vaccines, or pandemics some heartfelt work and recognition needs to be done from within the fields of the sciences. I believe that art can play an important role here.

What would a physics that, "chooses existence and life over the dictates of colonial, capitalist, patriarchal systems" (Mignolo & Walsh, 2018, p.50) look and feel like – what could it do and who would it be doing it for? This is not a question that I began my dissertation research with, but one that I have come to through the ongoing processes of my research practice and fieldwork - something I will continue to pursue beyond this stage of my practice and research with increasing urgency.

26. Still Image from *Viriditas,* HD, Color, Stereo, 20 minutes. 2019-2020

4.6 ***On Counter-allegory***

> Allegory is more than the use of rhetorical tropes. It is the animation of universalizing figures such as planets, species, nature, and the human into narrative – and thereby into space and time. (DeLoughrey, 2019, p.5)

The work of Karen Barad already explicitly queers physics by re-narrativizing, situating and (re)contextualizing it, using findings and phenomena from quantum mechanics and quantum field theory to undo some of these disciplines' implicit logics from the inside. Part of the diffractive, critical interferometric method of my project contributes to this work by situating the master discipline of theoretical/particle physics as a cornerstone in the cosmology of Western modernity/coloniality. In the vein of Sandra Harding (1986; 1991) who pursues

issues with modernity through feminist science studies and postcoloniality, and also made quite apparent in Bentley B Allan's *Scientific Cosmology and International Orders* (2018), as well as Mignolo's *Darker Side of Western Modernity* (2011), the critical interferometric practice of a diffractive aesthetics and methodology discussed in the previous chapter (or prologue) also articulates this reorientation of Western rationality as a function of a cultural cosmology. My method for reading the field of physics as a cultural cosmology requires considering their narratives and communications as story-telling practices.

The choices that I make in highlighting histories, entities, forces, and elements, as well as other non- and more-than-human 'characters' in my moving image work erodes some of the restrictive boundaries physics has built up around itself as a means of exclusion from critical cultural observation. Over the course of this chapter I came to the realization that one of my key methods has been reconsidering and re-presenting the allegorical descriptions of physics' claims, working with them to de- and re-contextualize physics labs and experiments in their historical, environmental and settler contexts – using claims from cultural narratives and working with those stories in their original or expanded contexts to complicate the sites and practices of experimental physics. *Viriditas*' focuses on ITER's claims like: "harnessing the power of the sun" and "bringing the power of the stars to earth" from communications of nuclear fusion technology. This solar-cosmic trope however has a much longer and multidimensional context, a holographic that I transcode through the poetics of the work. By unsettling this trope and tracing its lineage beyond physics' self-inoculations from cultural and social contexts, I pass through and resituate physics' dark histories and surreal origins in premodern alchemy, its later highly imagistic tendencies. For, 'harnessing the power of the

stars' is nearly as old a practice as human civilization itself and can be found in multiple contexts, frames of reference and historical and conceptual sites.

27. Still Image from *Viriditas* 2019-2020 taken at the ITER construction site in 2018. "Bringing the power of the Sun to Earth"

Here thinking with Elizabeth DeLoughrey (2019) has been very helpful. In the second chapter of her *Allegories of the Anthropocene* entitled "Planetarity: Militarized Radiations", she examines a number of Marshall Islanders novels that take as their point of departure the hundreds of atomic bomb tests that have irradiated the human race through atmospheric dispersion, and, more significantly, decimated the local culture and ecology - evaporating islands, inflicting illness and death as well as leading to the precarious Runit Dome.[38] DeLoughrey specifically departs from the notion of the *daemonic* and its function in allegory to

[38] The Runit Dome is a Marshallese radioactive waste depository constructed by the American military in the 1950's which continues to pose a significant threat due to its ongoing deterioration and sea level rise.

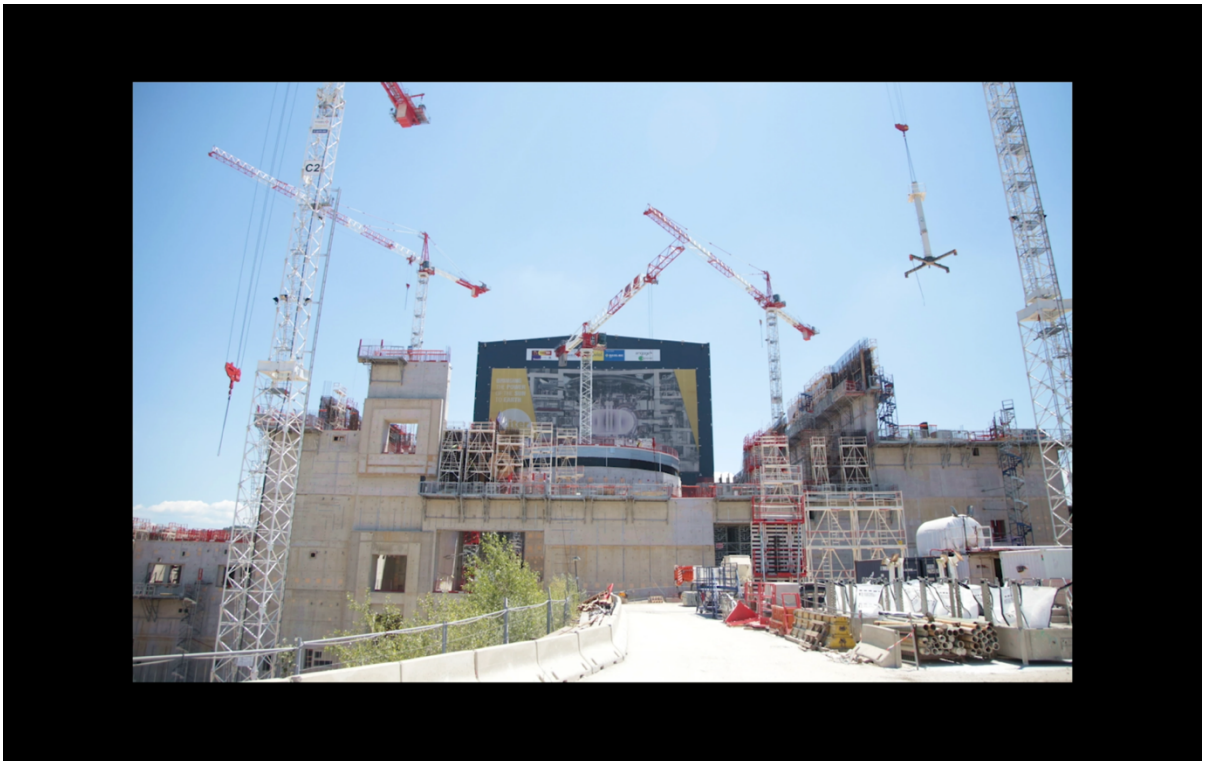
link and communicate between parallel worlds (between the divine and the mundane, or between physical and spiritual). In the case of both Judeo-Christian allegory and atomic science, the daemonic emissary can be understood as that of light and/or energy itself. Bruce Clarke, one of DeLoughrey's critical foundations for the chapter, "has demonstrated the ways in which the discourse of science, particularly physics, relies on allegory" (DeLoughrey, 2019, p.64). "As a discipline for the reproduction of the sort of knowledges that enables persons to seize powers previously reserved to the agency of the divine, science has often taken on the allegorical attributes of Luciferian [daemonic] enterprise" (Clarke cited in DeLoughrey, 2019, p.65). This *heliotrope* of light and radiation as master metaphor has been persistently used to naturalize nuclear weaponry, where physicists and governments 'harness the power of the sun', rendering their weaponry as a cosmic object rather than a military lab product, effectively "rendering the detonation of more than two thousand nuclear weapons since 1945 almost invisible to history" (DeLoughrey, 2019, p.66). Crucially, DeLoughrey's method "puts pressure" on the use of this daemonic figure to examine its function "rendering these histories more legible" (Ibid). In one such example of the extent of the heliotropes *twisted* function she uncovers, "News reels from AEC [television production company] about the nuclear tests at Bikini Atoll feature[ing] the displaced Islanders singing the tune 'You Are My Sunshine'. These metaphors invoked the sun's power in a way that deliberately 'confused' the public… eclips[ing] the sign of violence of nuclearization and radiation" (DeLoughrey, 2019, p.74).

Considering DeLoughrey's research on the heliotrope in nuclear testing and colonialism in the Marshall Islands, we could also think here with the photographic project of German artist Julian Charriére who travelled to some of the radiated islands to photograph the structures built

on the islands to house cameras. These nuclear bomb shelters extend the body of the camera out into brutalist cement architectures. Thoughtfully, Charriére left his exposed film buried in the sand on the islands, collecting them hours later, allowing the radioactive particles in the beaches to imprint themselves in the photographic film, again 'rendering these histories more legible'. Arjuna Neuman and Denise Ferreira da Silva's film *4 Waters: Deep Implicancy* (2019) takes 'a planetary view of the present' by traversing four of Earths largest water bodies to focus on the elemental, migration and "to imagine the possibilities of a world without time, measurement, accrual or notions of value—a world free from the destructive consequences of the Western mind." (2019) In their London exhibition at the showroom they've revealed considerable footage and interviews that did not make it into their art film, but that was shown alongside it in the upstairs office space – an exposition of research revealing a considerable amount of time and attention in the Marshallese Islands and its colonial-nuclear legacies that have forced migration, poisoned landscapes, both human and non-human bodies, and that continues to wreak havoc..

When we were onsite at ITER a few other tropes and analogies were apparent. There were playful comments about the relationship of cathedral builders in medieval and renaissance Europe and the construction of the ITER reactor. The analogy of cathedral builders who worked tirelessly constructing something they would never see to completion, is applied to the reactor, where many builders, engineers and scientists will indeed also not see this operating in their lifetimes (the first test ignition is currently set for 2040, though this reactor is only an experiment for proof of concept and not an actually functioning, energy distributing reactor, expected sometime in the 22nd century). There was a great sense of pride in the people who worked there, from management to construction crew, because they truly believe

in the value of what they are building, in the possibility of a global energy infrastructure 'game changer', contributing significantly to a greener, cleaner future, understood as a civilizational hurdle. Off handed comments about ITER as a cathedral were aplenty, the main hall even being referred to as 'the chapel', lending an air of gravity to the site and work. These renderings of the divine interestingly links their practices to the past and had set my mind racing with the premises and metaphors of these descriptions that were taken both seriously and in jest. This was one of the first times that I reconsidered the claims of the ITER's "Bringing the power of the sun to Earth" also in this deeper allegorical and historical context, eventually leading to a new research stream that led to *Viriditas*' realization. In thinking of the practice of harnessing the stars or sun, one might consider the old solar-deity tropes appropriated by European Royals, or the place of astrology in the development of astronomy. In my case I was taken by the multiple roles of 'Suns' in the alchemical tradition, and the intent by premodern 'scientists' to capture and use their power to transform minerals and spirits into one another. By reformatting the heliotropes of fusion energy and its religious analogies *Viriditas* manages to challenge the narrative of 'progress' in imperial-scientific history, troubling and complicating their claims.



28. Still Image from *Viriditas* 2019-2020 taken at the ITER construction site in 2018. Image of the construction area of the 'cathedral/chapel'.

4.7 Participant Vocabulary

There is a tendency to try and police what physics is or means from within physics, something that I have challenged over the course of my career and which is met with varying degrees of praise and distaste. I am interested in bringing physics back to culture, and I'm interested in what is relevant about physics from outside of physics, articulating and contributing to its shaping as a cultural practice. In the same way that quantum mechanics shows that there is no such thing as a mere observer - rather that scientists and instruments are agential in the construction of facts and knowledge emitting from laboratories - my role within these spaces is also that of a participant narrator in the constructions of their stories. Physics, historically populated by an exclusionary ethno-class that neglects to take any meaningful, transformative consideration into its difficult histories, nor having the cognitive or

emotional tools to do so, still borrow from philosophy and cultural affect to dress up their claims and investigations. Their appropriations are often flat and one sided. One experiment seeks to answer, 'why is there something rather than nothing?', thus speaking merely of physical matter- the presumed substrate of all experience. In another vein, 'unlimited energy' is one of the claimed pursuits of fusion/plasma energy research, even though no scientist or engineer in the field would actually stand behind such a preposterous claim in their epistemic community.[39]

"Scientific constructs have become the model for describing reality, rather than one of the ways of describing life around us," wrote Ursula Franklin in her in *The Real World of Technology* (1989, p.31). It is worth citing at length Meredith Meredith's Berlin Biennial essay reflecting on Franklin's thought and words here:

> At issue are the practice's overly broad application and its weakness when approaching contexts from which a constant variable can't easily be isolated. Human experience, emotion, and affect, with their infinitely rich and shifting contexts, is not conducive to scientific "proof." In a world in which science is the model, individual and shared experience does not "count" alongside other much more easily "provable" facts. The requirement that something be proven scientifically for it to be legible also means that

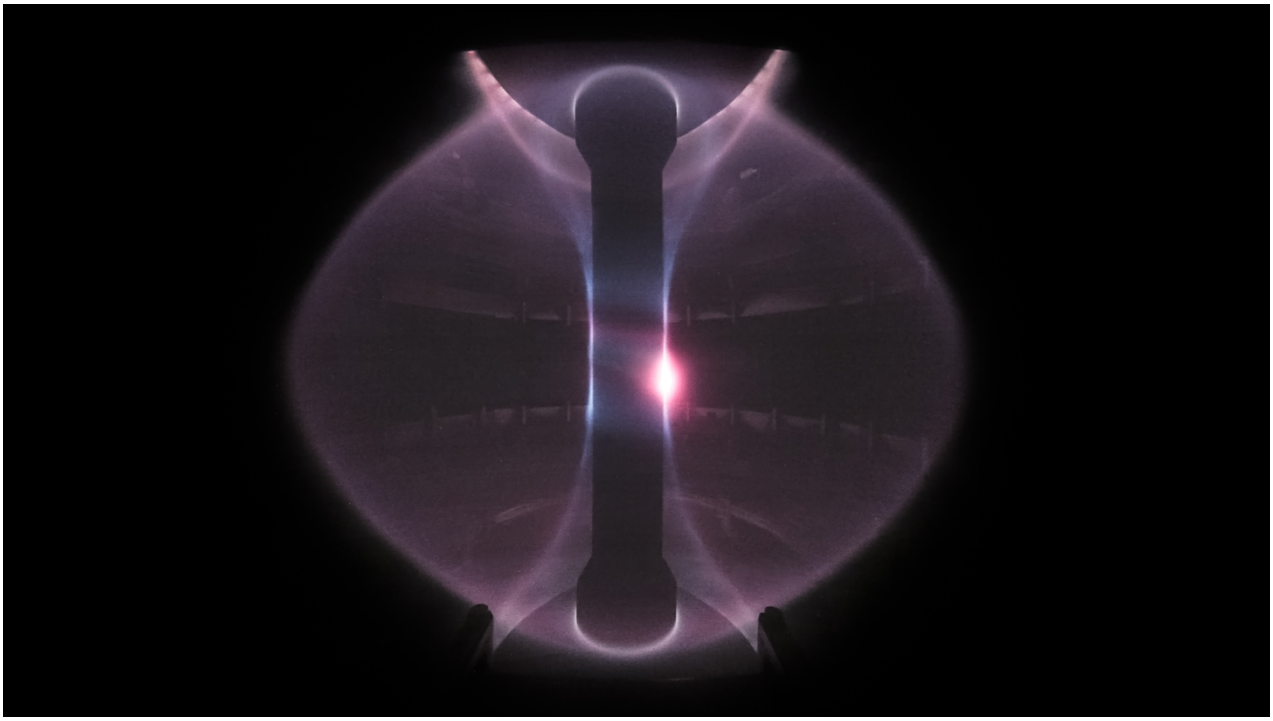
[39] We know that fusion energy is limited because it requires resources that are finite, and after having had done some preliminary research into its potential contribution to a future energy grid, its total output is significant, but still, at its maximum output it less than 15 percent of global production in the 22nd century (if indeed it ever works). See: Salvigni, D. *Do we actually need fusion energy at all?* 2017. https://www.euro-fusion.org/news/2017-3/do-we-actually-need-fusion-energy-at-all/. Nonetheless, it could substantially reduce reliance on dirtier energies of nuclear fission and fossil fuels. For more information please see also: http://geohumanitiesforum.org/creative-commissions-project-update-in-the-future-perfect-nuclear-and-nugatory-waste/ by Julian Weaver,

> the experts, those with education, standing, and access to scientific authority, become the de facto arbiters of whose experience and concerns are valid—and whose aren't. A position with significant power. This privileging of the generalizable and scientifically "provable" at the exclusion of lived individual experience is central to the way in which our shared story of progress can so comfortably (and conveniently) focus on the artifacts extruded by innovation and leave the human cost to the side. (Meredith, 2015, np)

Making shared and individual experiences count is what some artworlds do. In this critical study of fusion narratives, and in reformatting them to account for histories and human costs, my work contributes to a project of queering physics by rendering it strange and odd to its own community, complicating it from within with feminist practices of situating and counterallegory. This nuanced dismantling of their own descriptions and logics also contributes to an accounting of the privileges and exclusions of the discipline, working to loosen and undo some of colonial modernity's hold by chipping away at theoretical and philosophical infrastructures that support it.

When I am in the field I am not merely an observer or recorder/capturer - though that is of course a critical part of my function and practice - but I am also, significantly, a participant in the production of universe, an agent constituting and contributing to cosmological discourse through my relationships and influence at some of the highest levels of experimental and theoretical physics. Allan's argument in *Scientific Cosmology and International Orders*, "suggests that future developments in scientific knowledge will continue to shape and reshape international orders", and so being present in these spaces can have resonances in the lived

worlds and meanings of future generations (2018, p.274). As an example of my influence in the discursive formations around experiments and instruments, there have been a number of occasions with Dr. Elisa Resconi, the director of the SFB1258 neutrino and dark matter group at the Technical University of Munich, when she has asked me if it is okay that she borrows certain language from me to use in her meetings and talks, and she quotes things I say in her speeches and public appearances. I feel that this is a significant example of an artist in the field working as a broker between theory and culture with the sciences, helping to define and contribute to the transdisciplinary production of meaning. Although these exchanges might appear minor on the surface, Allan has shown how the semantic borrowing between scientific academies and political institutions has had significant transformative potential to political discourse over longer periods of time. This might also develop into a larger argument about artists working in any scientific field and the need to push beyond mere science representation and communication, to really engage at the level of ideational formation of instruments and experiments leading to a better more reliable social comprehension of what science is and does. This is of course demanding in terms of inter- or trans-disciplinary work and research and requires a level of access that is perhaps quite rare, and indeed a privilege of my whiteness, but could become an art-science methodology that disrupts the traditional perceived flow of knowledge distribution and epistemic hierarchies that is often presumed, arrogantly or insensitively, to go only one way.



29. Still Image from *Viriditas,* HD, Color, Stereo, 20 minutes. 2019-2020. Image of plasma from the inside of the MAST fusion reactor (CCFE) while ignited.

4.8 **Knowledge, Cosmology, Alchemy**

The 21st century has seen an increase in western epistemic practices increasingly looking towards and borrowing from indigenous knowledges and cosmologies, in both respectful and unfortunately disrespectful ways. This turn, sometimes called the ontological turn[40], connected to anthropologies of the South, nonetheless has been critiqued as an ongoing form of neocolonialism, exploiting indigenous and southern cosmologies for the furthering of neoliberal, capitalist 'knowledge production' in Western universities.[41] When it is done properly it can be helpful "not as a premodern reflection of human thought, nor as a 'world-view' different from northern and/or western thought, but as a thought to be engaged with because

[40] See also 'controlled equivocation' in de Castro, V. 2015., Holbraad, M. 2012., Kohn, E. 2013.
[41] See Smith, L. T. (2013). *Decolonizing methodologies*

its architecture can undo the presuppositions of Western… thought" (Bobette & Donovan, 2020: 19). This appropriation can leave a bad taste in the mouth when researchers cherry pick ideas and concepts, methods and practices without self-critique, without doing the work necessary to align with the implications. At a recent lecture in the CREAM Futures online series Chris Creighton-Kelly, co-director of Primary Colours in Canada, a community and organization that emphasizes the centrality of art practices that are Indigenous, Black or from People of Color, introduced to CREAM faculty and researchers the Indigenous decolonial strategy of the "Five R's": Relationships, Respect, Reciprocity, Responsibility and Relevance that are required within progressive research practices and settings, such as the running of art and academic institutions. Other strategies mentioned by Creighton-Kelly that I believe my practice pursues and aligns with are: polyvocality and the breaking down of barriers and the accepting of multiple forms of expertise rather than only those that follow western scientific, aesthetic, or academic standards.

One way I have operationalized a decolonial approach in Viriditas is to think carefully with concepts of the *intangible* (Gomez-Barris, 2017) and the *ineffable* (Campagna, 2019). I have chosen not to uproot Andean phenomenological concepts, but rather to find an equivalent concept in a European alchemical tradition that I can situate in proximity to my field sites. I have thought alongside intangibility, and ineffability (Campagna, 2019) - each intertwined - as a route around Master narratives of reality, capable of expressing something beyond the quantification of Being and Experience, rooting and routing this knowledge through a critical practice within a contemporary analysis of physics' landscapes. This has developed an awareness that has also led to the impetus for the *Viriditas* lecture-performance to be rooted

in a premodern European context. The often-disregarded knowledge of alchemy and its explicit historical role in generating the scientific method is often overlooked and made an object of ridicule specifically because it is perceived pejoratively as *traditional* in regard to modernity/postmodernity. To look to alchemy, to be inspired by its cosmologies is in a way a look to European ancestry (which is not innocent but which is left out of many cultural equations and ridiculed within histories of science) and to avoid uprooting specific Indigenous knowledges. Alchemy was a practice both spiritual, mystical, religious, material and scientific. Alchemical practices were also multiple and varied across regions and cultures, existing for more than a millennium, and crucially, initiated by women.[42]

A focus on European alchemy, specifically how alchemists later representations were often heavily pictorial and animistic, plays a significant role in the Viriditas work which hosts manuscript images dating back from the 12th century, but most substantially from the 16th to 18th century. One can easily see within many of these images the sources of inspiration for much early modern painting, including the early 20th century proto-surrealist movement of Giorgio de Chirico's *Scuola Metaphysica,* as well as surrealism's visions, and even the spiritualist movement adored by Art Brut. As mentioned earlier, the very term *Viriditas* is the notion from the 12th century polymath, mystic and saint Hildegard von Bingen. Von Bingen's Viriditas names the vegetal energy manifestation and force of the *greening green* – that force which prompts the green things to grow, reproduce, exceed and nourish (Marder, 2020). In another text on Hildegard's symphonic Viriditas, Michael Marder writes:

[42] Mary the Jewess and Cleopatra the Alchemist are two of the originary founders of alchemy, using weights and measures, as well as developing many of the apparatuses used in distillation processes.

> The voice of Hildegard von Bingen (1098–1179) is still fresh – ever-fresh, ever-green – despite having first sounded almost a thousand years ago. What resonates in it is nothing like the force of the monumental "classics" that are supposed to stay eternally relevant in their immovable veracity. Her figure is not that of a towering rock that overshadows the subsequent history of thought, let alone the inherently shadowy history of the unthought and the unthinkable but intensely and mystically experienced. It is, instead, that of a tree, of plantness or vegetality, of greenness and greening (viriditas), perpetually on the verge of self-renewal, reaffirming the promise instilled in creation. With a garden in her name and cosmic vegetality in her visions, Hildegard intuited the sonorous sorority of being and endeavored to express it in her symphony in green (Marder, 2019, p.137).

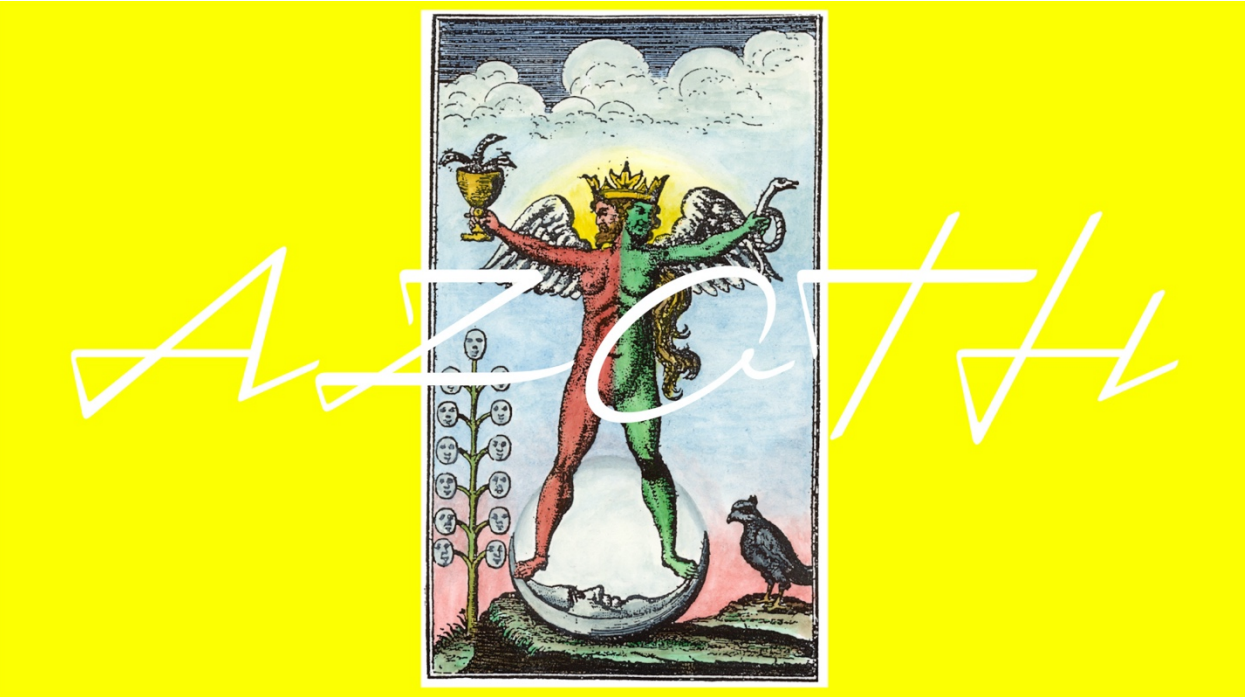
The eponymous Viriditas as a concept and as a function plays throughout my audio/video lecture performance that can be experienced through the work. As a 'counterallegory' to the heliotrope's obfuscations and exclusions, Viriditas rethinks the very notion of sustainability and clean, or green energy, multiplying the range of energies we may even be considering – energies operating beyond the Western Cosmologies capture. What is important in fusion's heliotrope is of course the link to the sun as a natural life-giving energy source which plays into societal requests and needs for energies that do not produce abundant waste products. Over the course of my researching von Bingen's *viriditas* through the writing of Michael Marder (2020; 2019; 2018) and by listening to her choral music performed by contemporary musicians I have found something of the notion of viriditas in the emergence of climate awareness and 'green new deals' that prioritize climate change, racial justice, and mass extinction awareness

in the entangled continuum of which they relate. This is one of the key reasons there is so much to gain by considering European ancestry rooted in Medieval thought, before the advent of scientific *mechanics* and the brutal fixation on materialistic measurement. Enlightenment and Galilean thought, as discussed in previous chapters, helped to pull Europeans out of the grip of a tyrannical religiosity and divine providentialism that plagued the continent and reinforced divine law and dynastic aristocratic 'blood lines'. But the essential, we might call *animistic* or posthuman tendency to see the vibrancy of matter, the liveliness of the inert, that which cannot be measured, is something that so many contemporary philosophies and theories are struggling to meaningfully and coherently resuscitate during these first years of the third millennium.

Considering the implications of quantum phenomena Denise Ferreira da Silva discusses how, "An ethico-political program that does not reproduce the violence of modern thought requires re-thinking sociality from without the modern text. Because only the end of the world as we *know* it, I am convinced, can dissolve cultural differences' production of human collectives as "strangers" with fixed and irreconcilable moral attributes" (2016, p.58 emphasis in original). In this concise paper *On Difference Without Separability* of da Silva she thinks with the quantum reformulation of onto-epistemology, underlining that *how we know* needs to change. Lummi Nation member and educator Michael Marker's (2018) *There is no place of nature; there is only the nature of place: Animate landscapes as methodology for inquiry in the Coast Salish territory* reminds us that quantum theory has been used as a paradigmatic example of cognitive dissonance analogous to what western scholars and researchers have expressed when approaching Indigenous philosophy of place. In this incredible paper that discusses Indigenous concepts of place and Land, concepts

that recognize the sentience of landscape (and its awareness of us) he writes that, "Recognizing and acknowledging the ways places contain spiritual and mythic energy is a methodological position that opens possibilities for both expanding consciousness and building relationships with Indigenous people," (Marker p.260). In an age devastated by climate change, science denialism, and conservative political and media supremacy, *how we know* and the relations we have with other ways of knowing need to develop and develop quickly. The *pre*modern relationality found in the patterning and equivalence thinking of alchemy is a way to contribute to renewed understandings of brilliant, powerful, and caring matter while simultaneously highlighting ongoing histories of colonial hegemony. "In Indigenous cultures," writes Marker,

> "the landscape is more than simply a container for human history. It is the mind of reality shaping the stories of time and space. The proportions of events and the meanings of the ecological relationships between humans, animals, plants, and geologic forms are undivided from the physical experience of, as many Elders put it, 'being on the land.' Modernist social systems and knowledge taxonomies have too often followed a colonialist recipe for seeing the landscape as an inanimate surface for extracting, shaping, and constructing the artifacts of progress. This commodification of landscape persists in both public consciousness and environmental policies: oil extraction, mining, and massive hydroelectric dams are just a few examples. Place, in this Modernist ontology, has been abstracted, divided, and bordered into a component of reality rather than the progenitive holism that Indigenous knowledge systems begin with. Indigenous groups have always recognized a kind of kinship or ancestral relationship with entities such as rivers and mountains." (2018, p.453)



30. Still Image from *Viriditas,* HD, Color, Stereo, 20 minutes. 2019-2020

4.9 *Political Cosmologies*

"If indeed cosmological developments are central to the politics of the future," writes historian of international relations Bentley B. Allan, "then the articulation of new cosmologies is an important political task" (2018, p.284). Art practices can play an important role in producing narratives that do this, situating physics in landscapes of meaning, working towards more robust and mature sciences that grows out of an adolescent phase towards multivocal pluralistic cosmologies of relation and understanding that could change the world. But here I am suggesting that we don't continually need *new* narratives, we also need to reclaim from times past, from previous models and methods that can re-new. But we also need to be able to respectfully engage with nonwestern and Indigenous knowledge because it has millennia of experience living in vibrant reciprocal worlds with the responsible protocols of the "Five R's".

Considering nonhuman agency in new materialism and Posthumanist scholarship, Indigenous philosophy can go much further because it already begins from a place of nonhuman and more than human agency, without having to constantly defend this understanding - it is already implied as Rosiek, Snyder, and Pratt have convincingly argued, and so they go much further (2019). “We have been working with these ideas for a very long time. Why are we not cited, sought out, and included in the conversation? Why are you acting as if we are invisible—again?” they ask (p.4).

> “[T]o someone already convinced of the ubiquity of non-human agency, the prevalent interest among Eurocentric scholars with justifying a departure from their inherited humanist ontologies seems like a highly provincial obsession, one that distracts from the more substantive work of shaping productive ontological relations with a world full of human and non-human agents.” (Rosiek et al. 2019, p.7)

Anticolonial Feminist situating practices also reach into expanses of time and agency that emphasize the particulars of situatedness and relations. “What is at stake?” asks Denise Ferreira da Silva in *difference without separability,* “What will have to be relinquished for us to unleash the imagination’s radical creative capacity and draw from it what is needed for the task of thinking The World otherwise?” (Silva, 2016, p.59). Da Silva’s text draws on the stranger findings of quantum field theories for their potentially revolutionary social implications which have yet to come to fruition, specifically *nonlocality* and its implications for radical relationality (radical love) (p.65). Speaking from the field of physics, what else has to change? What can a respectful anticolonial approach to these sites and practices unfurl in the fabric of thought,

feeling, and being? Prescod-Weinstein writes that, "It is in the context of an intersectional feminist standpoint that we begin to understand the severe limitations inherent to the Euro-American physics community's traditional self-construction" (Prescod-Weinstein, 2017a: np). What is certain is the need for fundamental rethinking of the 'real' which physics claims to describe and master, but which is (obviously) far more complex than human understanding, language, mathematics, or measurement, and much more expansive. British scientist J.B.S. Haldane once noted that, "the universe is not only queerer than we suppose but queerer than we *can* suppose" (Quoted in McCarthy, 2004, p.40). Physicists and cosmologists say they want to know Nature and the Universe, to describe how life arose, but perceive it through only one set of human eyes.

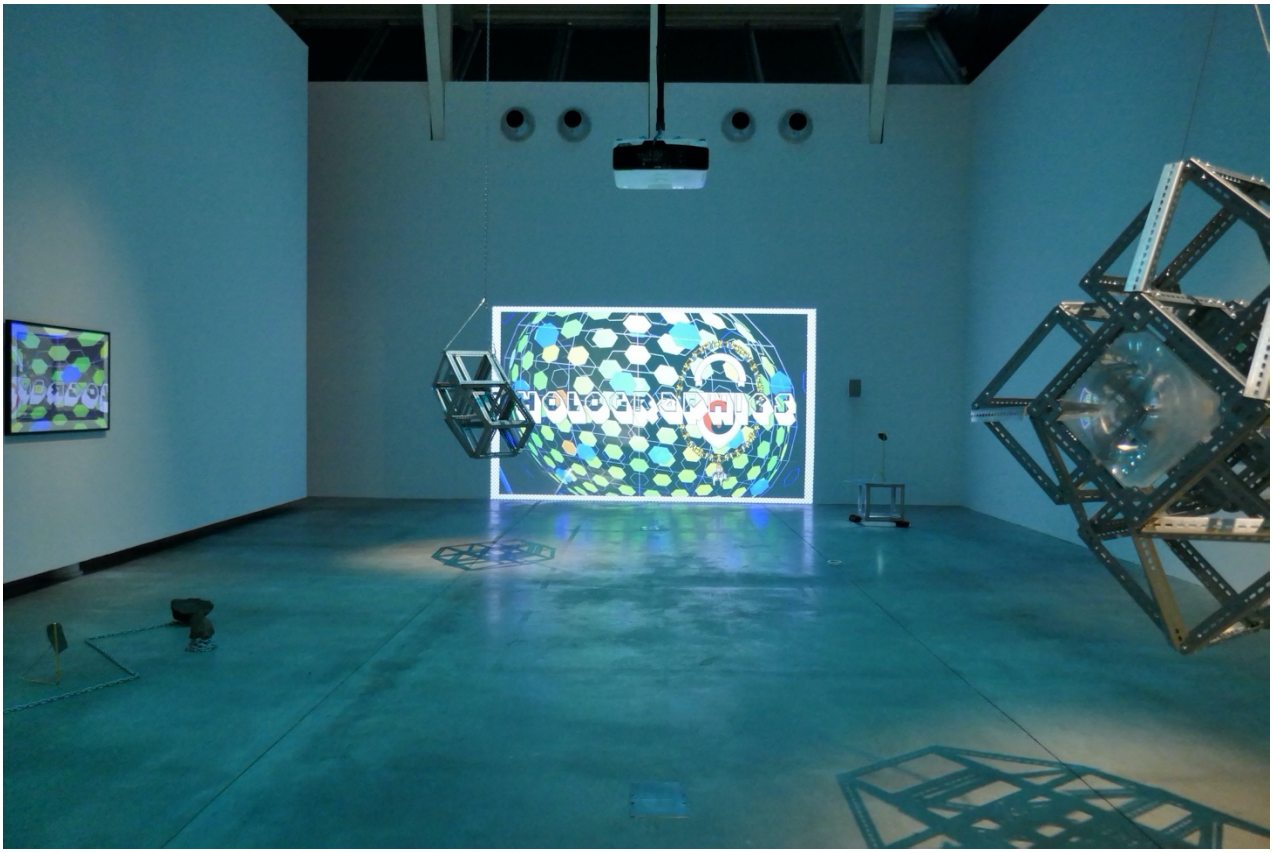
In practicing fieldwork and conducting research in and on Nuclear Fusion Experiments and Research Facilities, I noticed this tension between the narratives physicists tell and their actual deeper, longer historical trajectories. The wish to know and harness the power of the Sun is as old as humankind itself – it occurs in many of its solar deity motifs across cultures, and then through the alchemical tradition, apparent also, as discussed, in the nuclear weapon testing's heliotrope - now firmly connected to fusion energy platforms through *their* use of the heliotrope. With *Viriditas*, summoning multiple pasts opens onto what Michelle Wright has called an 'epi-phenomenal temporality' (2016, np) which transcends physicists understanding of linear time and 'progress', challenging epistemological narratives and offering a compliment to the diffractive understanding of time on display in Barad and Thiele's writings. Here I would like to ask if the *Quantum Reformulation of Ontology*, discussed in previous chapters, is not also necessarily also an anti-racist practice in the reformulation of scientific epistemology and

therefore in Western cosmologies? Art-science engagements, each upon meeting, in the best of cases, transform and enhance one another. Yet we still must actively re/think existing modes of art-science collaboration, as well as transform the relationships between artists and scientists, their objects and publics to have realizations of equal if not radically different epistemic value. Physics, as a specific form of knowledge tied to the fundamental infrastructures of modernity/coloniality, can learn from artistic practices rooted in postcolonial, antiracist feminist science studies.

Throughout the course of my fieldwork and this chapter I have begun to trace, outline and develop a framework of practice in art-physics engagements that can contribute to the critical interferometry of a holographic methodology. This includes situating practices, counterallegory, and respectful anticolonial engagement with and recognition of Indigenous philosophies rooted in nonhuman agency. Bringing diffraction back to opticality, we can say that practices of citation in art-sciences need to transform to include underrepresented voices, and their critiques of science and its colonial legacies, including claims of universality and absolutism. This means discussing these issues while in the field with scientists, and perhaps with other workers at laboratories that are not in privileged positions. Decolonizing the diffractive methodology means also not only critiquing historical and contemporary legacies, but also challenging narratives and offering counterallegories of scientific sites and practices. The diffractive method is often misconstrued as being merely about and focused on physics, but here it is equally and substantially about using science to reorient attention towards environments and ecologies.

Chapter 5

n-Land: the holographic (principle)



31. Jol Thoms, *n-Land: the holographic (principle)* in the exhibition 'Drift: Art and Dark Matter' at the Morris and Helen Belkin Art Gallery, Vancouver, 2021.

5.1 The Bulk of the Holographic: D = 4 + *n*

(A similar version of this text is used in the forthcoming exhibition catalogue published by K. Verlag *on the occasion of the exhibition's tour)*

Link to Media:

https://vimeo.com/504477365

Password: holograph

The smell is thick.

Chemical.

The sound is quite unlike anything I've experienced.

Pressing,

Hollow.

The air dense with particulate dusts, the light from the headlamps making the atmosphere all too apparent. The stone walls of the kilometers deep and long tunnels, the horizontal *drifts* of the mine, are held back by ubiquitous patterning of steel gratings. You can see the jagged rock through the repeating wiry squares of this steel mesh meant to be holding back debris from some of the 2000 meters of granite overhead. There is a forceful wind that pours itself loudly across our bodies, into our eyes and lungs. During initial research for this expedition to SNOlab, I had read that nearly half of the budget for the mine/lab is used strictly for air circulation, the heat itself emerging from the natural nuclear decay in the surrounding rock.

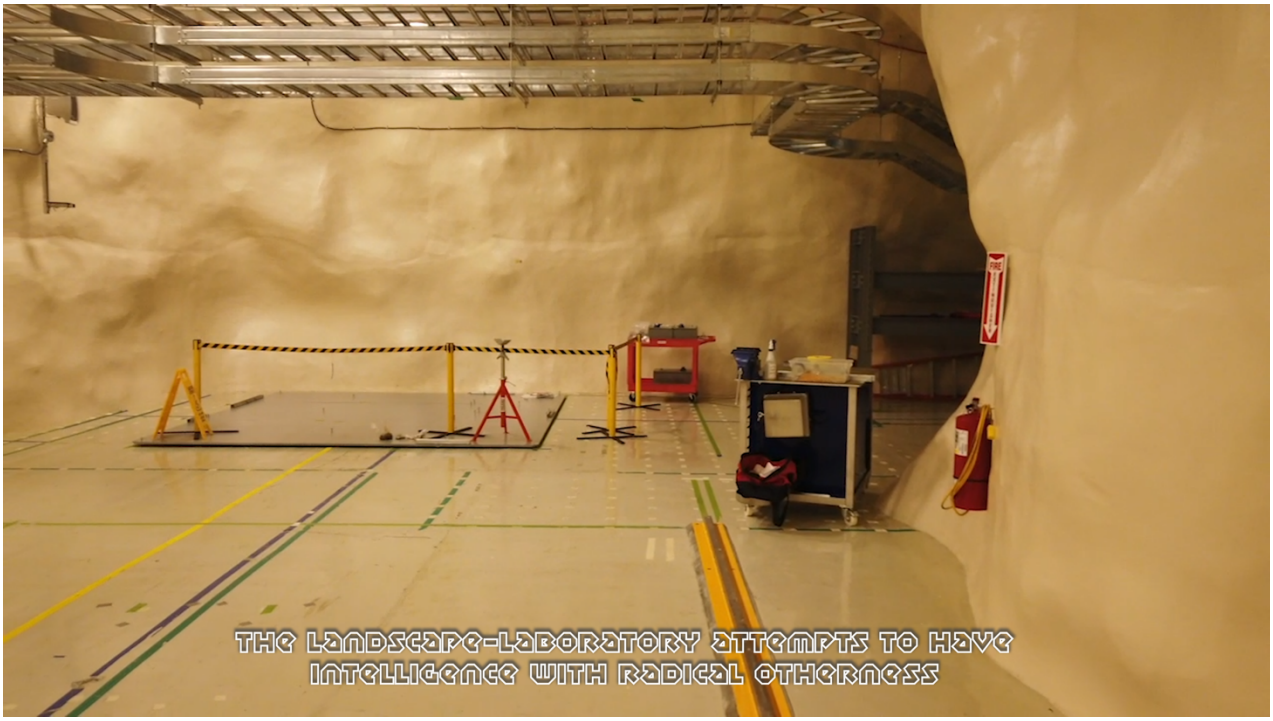
I read words like:

'Thorium contamination';

'geo-neutrino spectrum';

'muon-follower cuts';

'liquid scintillator with metallic oxide nanoparticles'.



32. *n-Land.* Jol Thoms. (4K still image) 2021.

The vast underground network of Creighton mine ‘drifts’, cut thousands of meters underground and with their vast and brash fan systems siphoning the air all around the circuity of the underground labyrinth, transforms the system into something once only imagined by poets: a planetary scale organ - humming deep in the ranks and stratigraphies of the ancient Precambrian rock of the Canadian shield. Within this Earth instrument (part mine, part landscape, part laboratory, part air circulation system) standing waves multiply into tremendous forces of vibration and resonance, vibrating my eyes, my own internal organs, shifting time and space, changing my frequency, allowing me to *see*.

There, 2000 meters underground, within the planets best preserved terrestrial impact structure, I am resonating with the anachronistic murmurs of this ancient wet planet while others search out the translucent energies of the cosmos that hold it all together.

It is important to know and think with that dense Precambrian granite that literally shields SNOlab from the chaotic radiative surface of Earth and cosmos: SNOlab renders the 2kms of rock overhead technical - as a 'redactor' - instrumentalizing it for advanced Nobel prize winning experimental neutrino physics, for dark matter searches, for peering through the impenetrable into the imperceptible. This fact of SNOlab's extending technologically into and as the rock makes it difficult to know where SNOlab actually begins and ends - it reaches *far out,* into, and becomes the landscape while receiving silent messages from the deepest regions of space, a silence so omniscient it seems to support the entirety of physical reality.

The neutrinos and theoretical dark-matter energy-masses that the laboratory-landscape searches are said to be able to pass through light-years of lead without ever slowing down, meaning the cosmos is for these neutral particle-forces *surfaceless*, without boundaries. This characteristic is part of what makes these flavorful particles so interesting to think and collaborate with. SNOlab is searching out the borderless and translucent energies of nature. In doing so it must also transcend naïve borders and limits, complicating notions of opacity and transparency, becoming landscape, environment, ecology. The distinction between nature and technology is doubly troubled, intra-active, entangled, transductive. Attending to the imperceptible elements of the laboratory itself, analyzing its tools and processes into constituent parts is a counter methodology that I use as a

means to know the laboratory, opening it up to its more-than. One such tool is the 'holographic principle' which posits 10, 11 and infinite dimensions of space, of which our 4D spacetime is but a shadow. Physicists use extra dimensions to try and understand their own equations that represent natures physical forces and particles, to understand how these entities might fit together into a unified theory. As in data sciences, higher dimensional space allows for more hidden, complex relationships to be uncovered and understood. Revealing more dimensions of SNOlab as a site means considering it on its own terms: as much a landscape as a laboratory. So I ask: what are its other dimensions?

As a landscape-laboratory SNOlab extends beyond the discipline of physics, out through the territory into other dimensions of society, culture, and environment. Like the neutrino oscillations the lab collaboratively described to win the Nobel prize in 2015, the lab itself changes its flavors depending from what perspective(s) one observes or participates from. Since it renders this vast Precambrian shield of granite as an assemblage, as a technology, it necessarily becomes entangled with the polyphony of meanings, issues, concerns, & stories it is assembled with there in the rock. To understand the science that goes on there, to understand the lab then, I as a holographer also need to trace these other dimensions of its otherwise imperceptible being.

A geometry of thought that passes through, around, between, underneath, over, and as:
The polytope of experience (as any-thing whatsoever: the forest, the rock, the waterfall, a beetle-mound, my hat, that train, your bread, this word, that murmuration; a cloudless day; the rain).

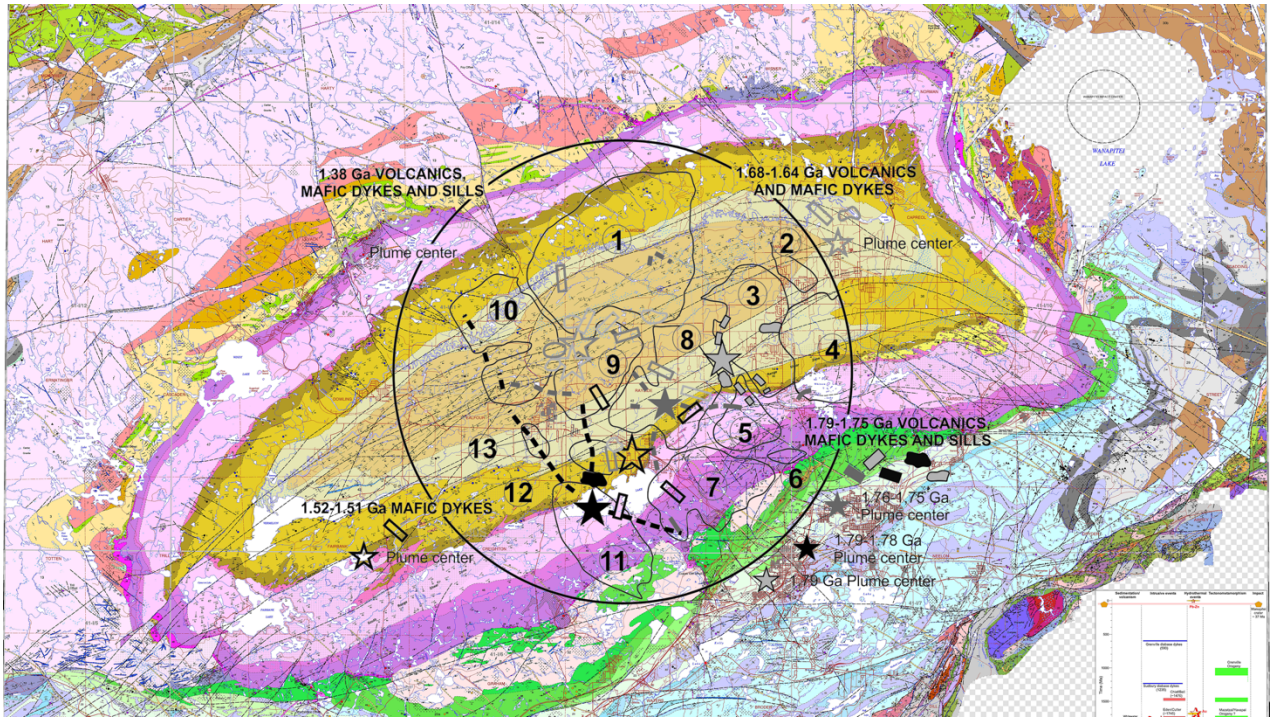
String and M- Theory each posit 11 dimensions, with 7 of them curled up microscopically, while quantum theory includes the possibility of infinite dimensions. Scientists at the McDonald Institute also use the holographic principle to speculatively 'print out' all the possible particles and forces of the cosmos through blackhole evaporation at future particle colliders.[43] My practice, following the holographic principle that makes extra dimensions knowable and workable for understanding nature, attends to the diffraction patterns that build up the holographic; the various waves of influence and more-than-non-human agencies that are at play in any spacetime. As these agents, particles, landscapes, and disciplines cross, intersect, and interfere with one another they build up higher dimensional structures that cast shadows in our own realm, allowing me to follow their geometries to concealed connections and relations - the shadows encoded with every other dimension while seeming flat or 3D.

Terms like 'inorganic crystals',

'matrix element calculations',

and 'high multiplicity transverse momentum signature'.

[43] See Ningqian Song & Aaron Vincent's brief and concise "Discovery and spectroscopy of dark matter and dark sectors with microscopic black holes at next generation colliders" for fabulative prospects of working with extra dimensions and blackholes for full spectrum and non-thermal particle discovery.



33. *n-Land* (4K still image) 2021.

1.85 billion years ago a 15 km wide comet with bits of asteroid frozen within it, crashed into Earth causing a 150-200km wide crater - a ring long deformed over the aeons of erosion and tectonic shifts. In the mining and geological maps of the area the striking oblong shape left from that cosmic confluence has the appearance of a wound, an egg, or some linear A remnant of an altogether alien glyph. And it is in this gash that SNOlab is located - deep within the second oldest and largest terrestrial impact structure known on Earth.

The impact from that unnamed comet was so dramatic that the mantle itself fractured and a large bowl of molten material spewed up from within the Earth forming what will billions of years later, in the Holo- and Anthropo-cene be mined and removed for artisanal, technical and economic advantage. The Sudbury Basin produces hundreds of tons of copper, nickel, and other metals

every year as a result of this impact so many rotations ago. The molten material that emerged from the Earth lures so many miners towards it that it has become the largest mining community *in. the. world*.

1.85 billion years ago in the Paleoproterozoic era time itself had an entirely different rhythm. The days are said to have been only 20 hours long, a year lasting 450 'days'.

The sheer scale of the variation in these terrestrial time signatures of Earth trigger a 5-dimensional shift in my own understanding of the site, the sounds, and spaces we visit deep underground. I've become indebted to this ancient convergence which has allowed me to enter deeply into the planets surface, troublingly. Ancestrally carved out by a primordial meeting between comet and planet thousands of various sculptures known as 'shatter-cones' to geologists, concretions formed by the pressure and heat of the impact are found in the surrounding rock, in the circumference of the impact structure, each cone pointing *in* towards the center of impact.

1.85 billion years ago that icy comet came down into a primordial supercontinent named *Nuna*. The intimacy of that event left behind these sculptures called shatter cones in a ring of engagement that goes on and on and on.

Nuna existed aeons before Gondwana or Pangaea, other well-known supercontinents in Earth's history. They are an ancient landmass. All the continents we know today, separated by water and 'national interests' were still connected back then, and life, though only single celled archaea and

bacterial mats, were associated in this simple, modest way. While there were no plants, animals or birds, there was *Nuna* and a vast, vibrant Ocean. 2kms underground in the dense granite of the mine, just a hundred meters or so outside of the entrance to the SNOlab, sounds resonating within the ancient rock invoke this otherworldly time and atmosphere, helping me imagine life, nature, space and time very differently; helping me to understand the complexity of the landscape that the laboratory has become a part of.

The meeting between Nuna and the comet is an essential yet nearly imperceptible part of the story of Canadas rich geology, of SNOlab and the Creighton mine – each institution owing a great debt to that unnamed comet that sunk into Earth so long ago, opening deep passages through time, Earth, and, in turn, possible 'portals to the dark sector' of invisible mass.

If we pass a 7-dimensional shadow/light across SNOlab, we can read the traces of its greater geometries, its various entanglements as they project into our less bulky 4D spacetime. We see Nuna for example, and their agential comet interlocutor in real time. But while these dimensional projections trouble time, they also indicate a still more complicated relationship to the land, the land that is rendered technical by SNOlab. Extending its boundaries out into the surrounding landscape, far beyond its creamy undulating beige walls - out into Sudbury Basin - the territory of this landscape-laboratory is found to also be subject to the historic *Robinson-Huron Treaty*, signed September 9th, 1850 between settler's and 19 Ojibwa bands of the Anishanaabek who traditionally resided on the north shores of what is now called Lake Huron.

34. *n-Land* (4K still image) 2021.

The 170-year-old treaty was unique at the time for a number of reasons, one of them being that payments were made in cash rather than goods, another being an important clause indicating increasing annuities payments: annual payments made to the tribe members for the use of the land by settlers: As the production value of the land increased overtime, it was written in the RHT that the sums to be paid annually to the tribes would increase as well. Today, and for the last several years, tribes of the Robinson Huron Treaty (RHT) are suing the Canadian government for having never had lived up to the nearly two century old treaty - the annuities never having had increased *since 1874*, in this the largest mining community on the planet.

SNOlab doesn't only make neutrino or even 'dark matter candidate' oscillations perceptible and measurable - but by becoming landscape, it also makes these other translucent factors

perceptible to me, entangled within the physics discipline. The value extracted from the land has, of course, increased exponentially, by orders of magnitude, many times over since 1874. Today, just the nickel value of the land in Ontario is valued on the order of some 4 billion annually, much of it coming from Sudbury and the RHT territory. Yet the Ojibwa members still receive only *4 dollars a year* for the last century and a half for their leasing of the land. This discrepancy in what is owed is not entirely dissimilar from the apparent discrepancies in our observations of galaxy rotation curves, indicating how dark matter and energy make up 96 percent of the cosmos, while baryonic charged matter makes up only 4%. In the coming years the courts, now in phase 3 of this important federal case, will decide the recursive and future payments - a significant, if not long overdue victory for the Robinson Huron Waawiindaamaagewiin who represent the 21 sovereign Ojibwa treaty signatories.

35. *n-Land* (4K still image) 2021.

In the 1970's NASA sent astronauts to train in Sudbury because it was most like the surface of the moon: more than 200,000 acres became barren from generations of sulphur dioxide gas, as well as arsenic, cadmium, copper, lead, nickel, and selenium chemicals from smelter emissions. Since then, major comprehensive ecological recovery programs have transformed the landscape back into a living creature using lime, fertilizer and trees that are more comfortable in these acidic conditions. The oaks that were once living there are now long gone.

The holographic principle in physics that utilizes 10 and 11 dimensional space for figuring out how natures forces and energies fit together is also useful for thinking how these multiple dimensions of the laboratory-landscape fit together in a site that is a mine, a 1.8 billion year old impact crater, the site of a major federal annuities case, and a dark matter laboratory.

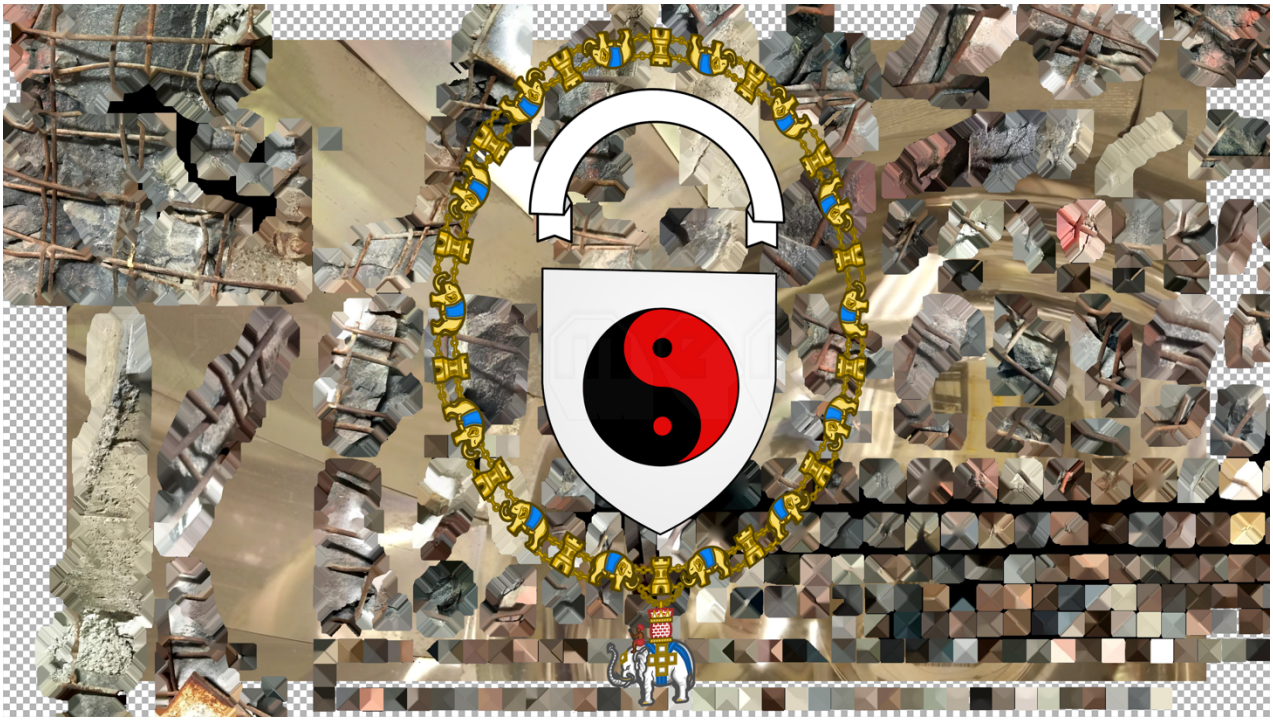
The theoretical reality of spacetime's hyper-dimensionality that allows me to work with multiple dimensions and geometries of the laboratory-landscape also, finally, signifies natures holomorphism, i.e.: its capacity to be fully present in each and every space, 'at every point of its domain' – a truly radical relationality that makes notions of entanglement seem almost quaint. Like Nuna (Earths ancient terrestrial connectedness), or like the anarchic neutrinos that unsettle a century of physics' best models, in the bulk of the holographic we can see the inner, outer, and other relations and connections that are otherwise obscured. These gesture beyond dualisms, universalisms, or other pre-quantum mindsets that continue to plague the world, its knowledge and behaviors. A holographic reformulation in my understanding of space, time, and agency allows me to perceive the worlds that celebrate difference, cherish nature, and signal beyond

arbitrary separation and division for a more comprehensive understanding of reality and experience, while confronting us with the limits of human reason and perception.

"To understand that there is a kind of perfection that excludes entirely our knowing of it is to understand completely the holographic, or scale-retentive nonlocality of the universe." (Wagner, 2017, p. 25)

The laboratory-landscape is a place where ideas of nature, time and space are being rewritten and reenchanted, where futures and bodies are being (re)negotiated in the elemental makeup of the universe, where fresh power is being slowly conjured through elemental and material reconfiguration. Inside SNOlab's beige walls are arrays of copper, argon, steel, tellurium, xenon, aluminum, plastic and so many other crystals, gases, liquids, and metals placed into extreme conditions and formations, with the faith that one day these arrangements may successfully invite a point of non-light into our vibrant baryonic cosmos, leaving deep impacts in our knowledge and understandings.

Cosmology is *always* also cultural, economic, political, environmental, social, and sensual.



36. *n-Land* (4K still image) 2021. (Showing the family crest of Niels Bohr).

Back in the laboratory, physicists and engineers work tirelessly seeking out the invisible particles that weigh heavily in their models of physical reality. They're underground using the 2kms of rock overhead as a technical device, as a cosmic radiation redactor, putting the shield in 'Precambrian shield' to good use. There in the meandering walls of the lab many layers of invisible or imperceptible phenomenon are in operation: from the billion years old impact event, to the land-use relationship with the eco-technical shield and the treaty that rendered the land extractable, opening up the underground drifts for the lab to eventually exist in and win a Nobel prize, that will allow me to travel deeper into the Earth than I could have ever imagined. There, deep in the Earth, I invoke a process learnt from a dream and hum into the rock a holographers chant. Over days I register a trace of the intangible poem hovering in a higher dimensional joy that something

shares from outside of our narrow spacetime continuum, beings from with/in the bulk respond and drift my mind towards an other-science.

The non-light of (our unknowing) the universe proposes tools and concepts with which to reveal the inherent connections, intra-actions, and errant resonances of spacetimematters infinite confluences. Thinking in and as a higher dimensional artefact that is holomorphic in its fractality, welcomes the fragment of the lemniscate in- & un- folding the body of the cosmic landscape, and 'new knowledge' and perceptions surface, smeared and far-out, oscillating and resonating unobtrusively.

37. *n-Land* (4K still image) 2021.

5.2 Documentation elaboration: Crossing Cosmologies

The following section shows images of the multimedia installation *n-Land: the holographic (principle)* with images from three photographers. The photographers names will appear as initials next to each of their photos: Paul Litherland (PL), Tim Forbes (TF), Jol Thoms (JT). n-*Land* was developed through a residency and exhibition project initiated by the Agnes Etherington Art Centre (Agnes) and the Arthur B. McDonald Canadian Astroparticle Institute (MI) in collaboration with the Nobel prize winning (2015) neutrino and dark matter laboratory SNOLAB – beginning in 2019 and now on tour in Canada.[44] Wth the documentation, I unpack the methods, processes, concerns, details, and challenges in the production of this new installation.

[44] *Drift: Art and Dark Matter* subsequently travels to Art Museum at the University of Toronto; Carleton University Art Gallery, Ottawa; Morris and Helen Belkin Art Gallery, Univeristy of British Columbia, Vancouver, and; Art Gallery of Sudbury, Sudbury Ontario.

38.

The first installation of *n-Land* occurred at Agnes and had a two-tone wall color scheme that was meant to reference structural colors of the laboratory and those colors perceived resonance with historical speculations about the most abundant color or wavelength in the cosmos. All visible structural steel in the clean lab of SNOlab was colored baby blue, while in Maggie Nelson's *Bluets* (2009) she speaks about how in 2002, after two astronomers who determined by analyzing the color of 200,000 galaxies within 2 billion light years of Earth, that the color of the cosmos was between an aquamarine and turquoise, found out it was in fact more of a beige, or 'cosmic latte' (Samuel, E. 2002). The laboratory is a class 2000 clean lab, meaning, regardless of being within a mine, it has extremely low levels of dust (one must shower to enter the lab 2kms underground). The wavy undulating walls of the lab are colored in a glossy beige. (Image: PL)

39.

The installation materials of gantry crane and the slotted steel material of the polytope sculptures are also in reference to the laboratory as an industrial site under constant construction, where scientific knowledge is in fact excessively material and exceedingly built through various techniques, practices, intra-actions, languages, and entanglements. This is not to say that scientific knowledge is false or misleading, but that it is a negotiation with the materiality conditions of the world. (Image: JT)

40.

Digital collages printed on acrylic were developed using a holographic method. This meant using a 3D scanner app to capture volumetric data of pieces of the laboratory. The app takes multiple images, stitching them together to make .obj files. In that process it deconstructs the images, particularizing and sorting them by textures and colors. It occurred to me that these flattened, abstracted files, spread out into 2 dimensions, is a similar technique that physicists use to analyze natures forces and particles. This technique was applied to the lab itself. (PL)

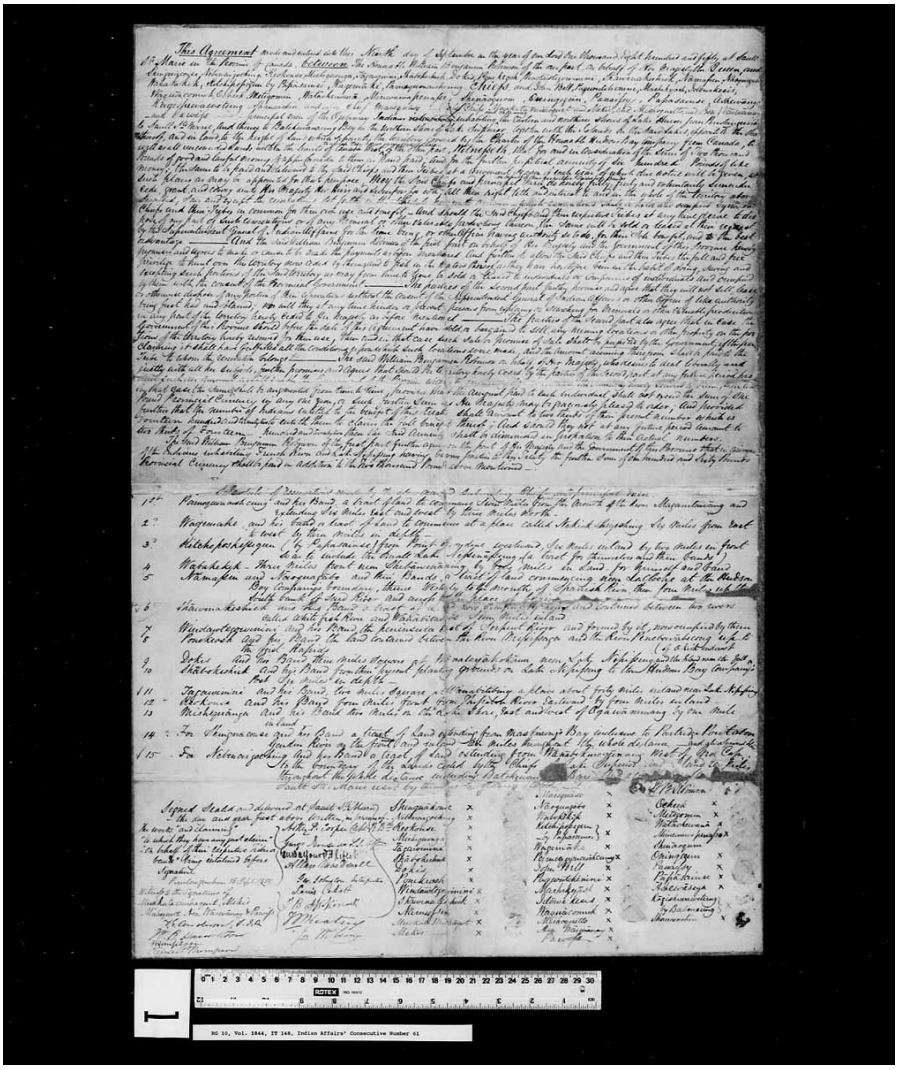
41.

During interviews at the McDonald Institute in summer 2019, a large gallery in their foyer exhibited different historical astronomical objects, one of which was a hanging Sloan Digital Sky Survey (SDSS) ‘plug plate’. Thousands of these plates were built and used in a multi-year project that was developed to make a virtual 3D representation of the observable cosmos for scientific research. The plate is used to block out, and thereby focus on, specific celestial objects. What you cannot see in these photos of the plug plates, is that there are tiny pin holes through out them, allowing pin light from stars to pass through. What struck me again is the dimensional transmutation used in the process of research and data production. Throughout the installation these sorts of dimensional re-iterations are present, including in the importance of the shadows that fall from the rotating polytope sculptures.

(JT)

42.

This facsimile of the Robinson-Huron Treaty (1850) obtained from Library and Archives Canada is included in the exhibition and its accompanying video as a different form of land acknowledgement. Land acknowledgements are given by all governmental, cultural and higher education institutions, usually in the form of a written or spoken statement acknowledging the ancestral land holders whom the territory of the institution is meant to be shared with and is a legally obliged process since the Truth and Reconciliation Commissions executive summary in 2015. In wanting to address my own identity as a settler colonial subject, I was interested to find a respectful way to address the territory that I was working in and considered that this very problematic settler document had a number of generative, uncomfortable implications (That was later proven through a series of demanded edits to my video). (TF)



43.

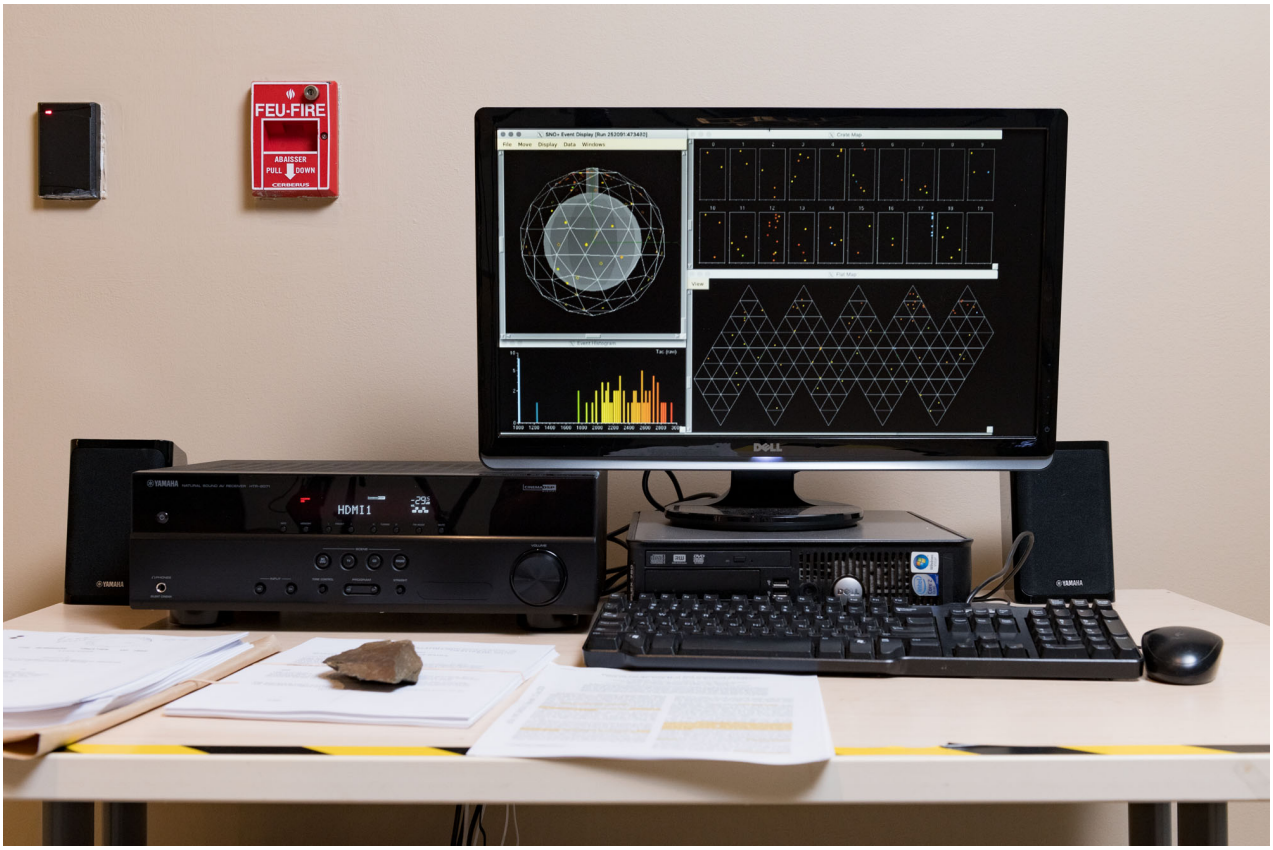
The RHT is currently part of a landmark federal court case, now in its third phase, that has ruled in favor of the 21 Ojibwe tribal signatories' legal claims to substantial financial restitution due to the provincial and federal governments failure to comply with the augmentation clause that was meant to share the value of the land through increasing annual annuities. The provincial government is currently appealing the federal ruling, however it is expected to have to payout some billions of dollars. This is a critically important case in a Canadian legal system backlogged with such cases, and whose outcome will undoubtedly set precedence for them. (Library and Archives Canada).

44.

The *n-Land* (2021) video transcodes the site of SNOlab, its many entanglements with landscape, mineral, mining, quantum meta/physics, treaty, and impact structure and is punctuated with the voice of award-winning physicist Miriam Diamond's reflections on the implications of quantum mechanics for rethinking reality and cosmology as well as her perceived need for more voices within her field. The sound of her voice intermingles with a 5.1 surround sound composition developed through recordings made within the lab and the drift tunnels leading up to it. There, 2 kms underground, massive fan systems constantly circulate and cool the air, turning the entire infrastructure into a planetary scale wind instrument or pipe organ. I spent hours in the loud, dusty particulate drifts seeking out the standing waves of pressurized points within the tunnels for this composition, listening to its strange music. (PL)

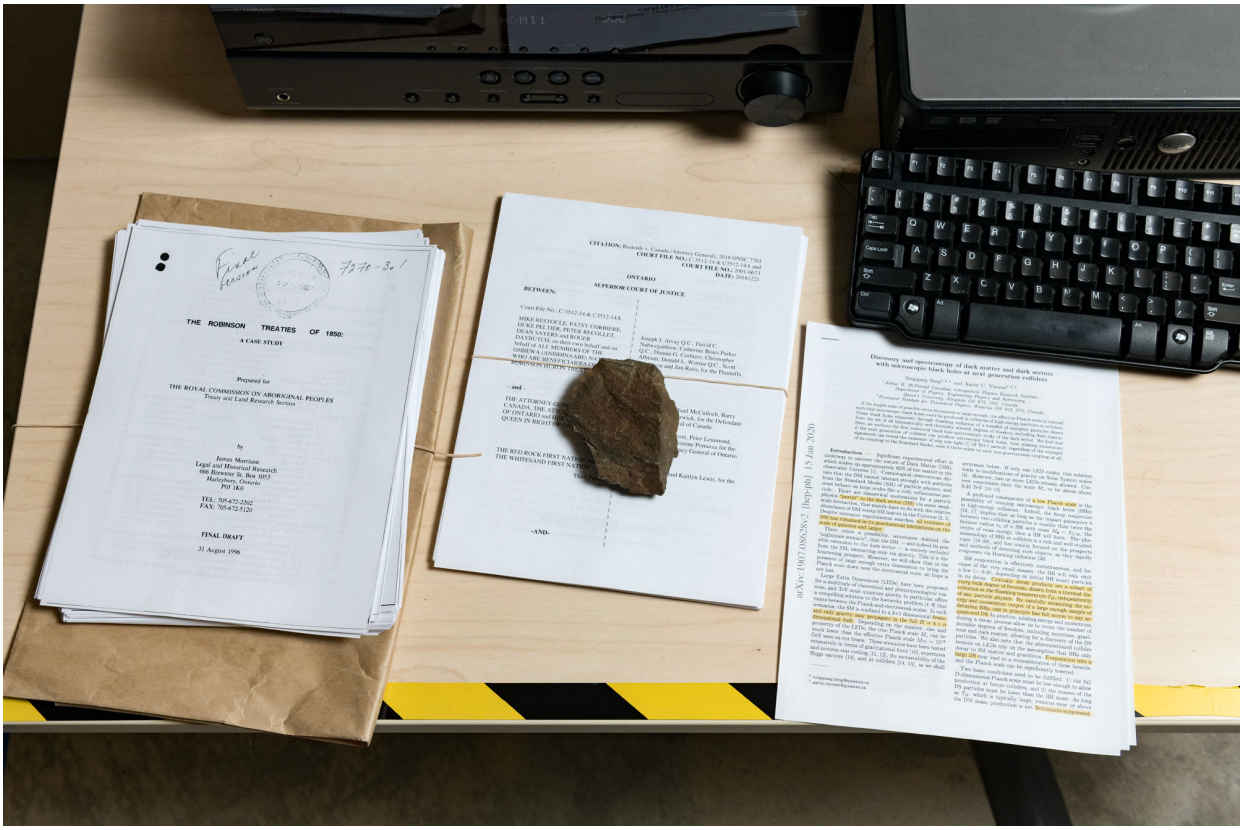
45.

A scientist's desk holds: 2 legal documents pertaining to the Robinson Huron Treaty's annuities case and a scientific paper by Ninqiang Song and Aaron Vincent of the MacDonald Institute. The latter discusses how future particle colliders could prove the existence of higher dimensions, and through that process, reveal all the possible particles in the cosmos (including dark matter and others). This paper by Song and Vincent influenced the titles of the set of sculptures called *The Bulk: Frameworks.* The term, 'the bulk' was introduced to me in this paper indicating the volume of extradimensional space that grows as you increase dimensions. ON the desk is also a video portrait using the SNO+ detector as recording device to capture our groups natural radioactive decay, a group portrait made with a Nobel prize winning neutrino detector. (PL)



46.

Part of the reason to go so deep underground is to shield the lab from the hyper chaotic noise of the surface, the surface that is open to the sky and all of its radiations. The SNO+ detector is filled with a scintillator liquid that fluoresces when charged particles track through it. When we walk above it on a platform, we cause the metals to decay, and our own natural decay at the atomic level send a noise into the detector which it recorded while the curators, myself and other artists were touring the SNO+ detector, directly above it. The video shown on the desk is a group portrait made with the SNO+ detector. (PL)


THE ROBINSON TREATIES OF 1850:
A CASE STUDY
Prepared for
THE ROYAL COMMISSION ON ABORIGINAL PEOPLES
Treaty and Land Research Section
by
James Morrison
Legal and Historical Research
666 Brewster St. Box 1053
Haileybury, Ontario
P0J 1K0
TEL: 705-672-2202
FAX: 705-672-5120
FINAL DRAFT
31 August 1996
CITATION: Restoule v. Canada (Attorney General), 2018 ONSC 7701
COURT FILE NO.: C-3512-14 & C3512-14A and
COURT FILE NO.: 2001-0673
DATE: 20181221
ONTARIO
SUPERIOR COURT OF JUSTICE
BETWEEN:
Court File No.: C-3512-14 & C3512-14A
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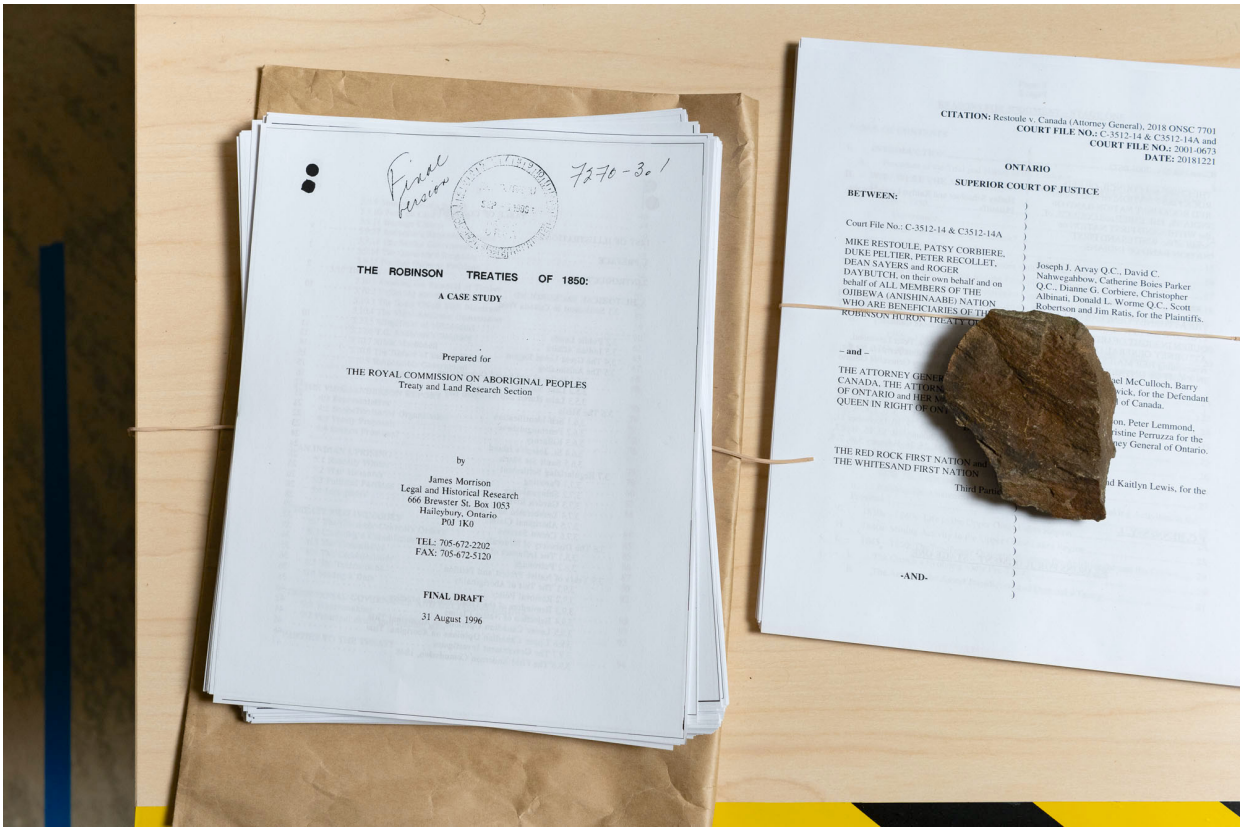
Discovery and spectroscopy of dark matter and dark sectors with microscopic black holes at next generation colliders
47.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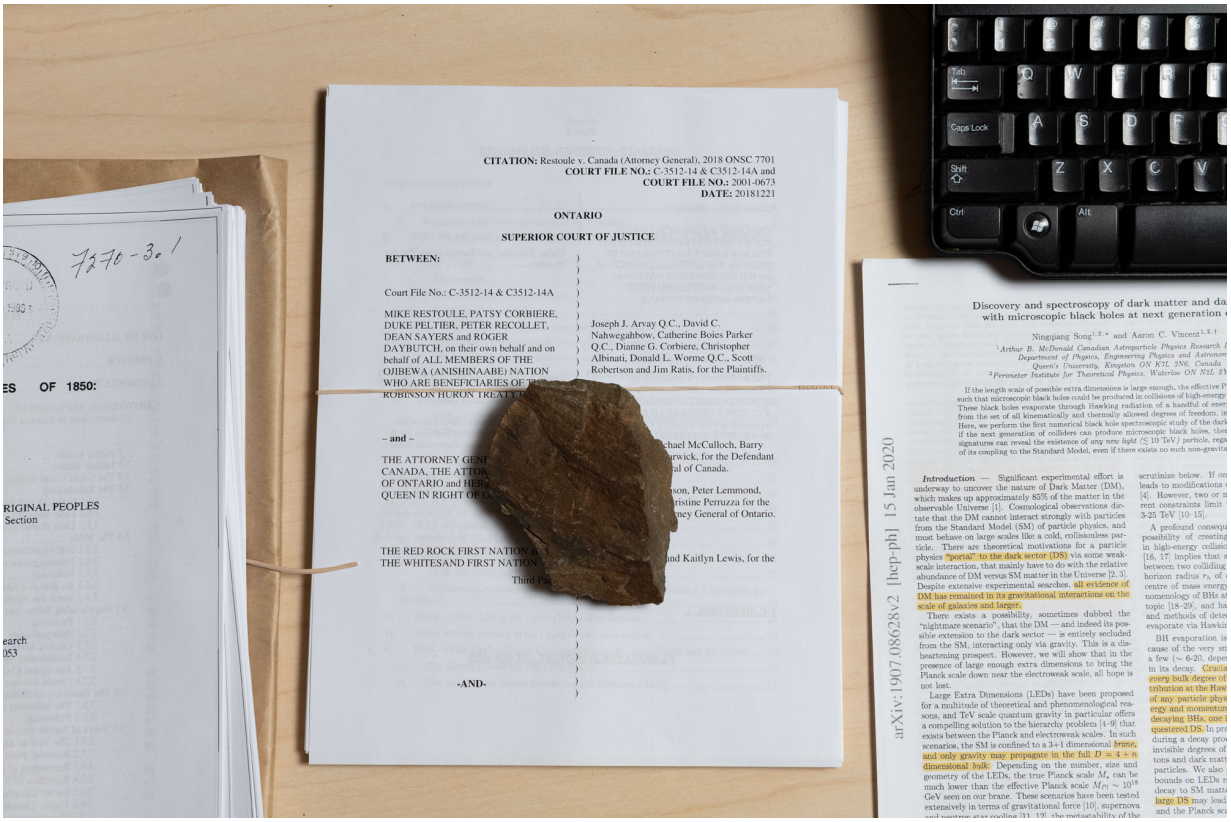
48.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Court File No.: C-3512-14 & C3512-14A
MIKE RESTOULE, PATSY CORBIERE, DUKE PELTIER, PETER RECOLLET, DEAN SAYERS and ROGER DAYBUTCH, on their own behalf and on behalf of ALL MEMBERS OF THE OJIBEWA (ANISHINAABE) NATION
Joseph J. Arvay Q.C., David C. Nahwegahbow, Catherine Boies Parker Q.C., Dianne G. Corbiere, Christopher Albinati, Donald L. Worme Q.C., Scott Robertson and Jim Ratis, for the Plaintiffs.
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Introduction — Significant experimental effort is
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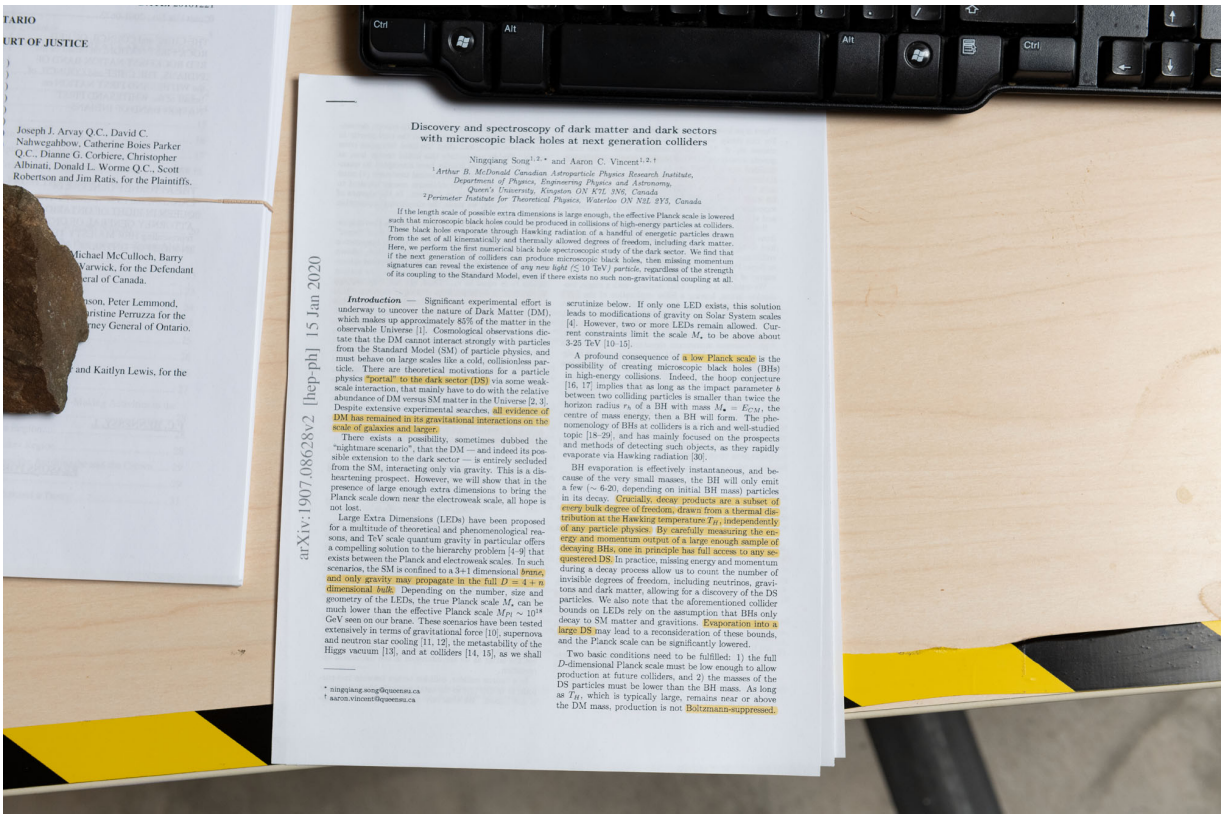
arXiv:1907.08628v2 [hep-ph] 15 Jan 2020

49.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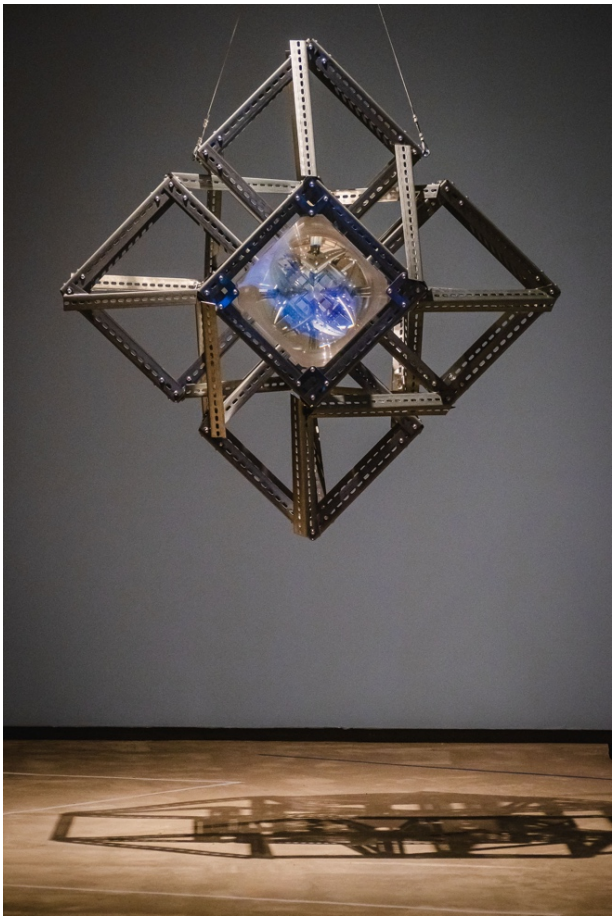
Discovery and spectroscopy of dark matter and dark sectors
with microscopic black holes at next generation colliders
Ningqiang Song[1,2,*] and Aaron C. Vincent[1,2,†]
[1]Arthur B. McDonald Canadian Astroparticle Physics Research Institute,
Department of Physics, Engineering Physics and Astronomy,
Queen's University, Kingston ON K7L 3N6, Canada
[2]Perimeter Institute for Theoretical Physics, Waterloo ON N2L 2Y5, Canada
Introduction — Significant experimental effort is
underway to uncover the nature of Dark Matter (DM),
arXiv:1907.08628v2 [hep-ph] 15 Jan 2020

50.

51.

Since the 2kms of rock over head is an essential aspect of the landscape-laboratory assemblage, rock from the region is also used throughout the installation as a way of sharing the experience of being at the lab, or in the meteor impact basin. A central method for my engaging with the laboratory was through dimensional analysis using the holographic method developed through earlier phases of my research and practice to elicit what is overlooked in the co-production of knowledge and reality through western sciences. The granite shown above has been degraded by decades of ‘acid’ rains from the smelting processes, also gesturing again to the toxic mining legacy at the site. (TF)



52.

The installation is considered entirely as a 7-dimensional artefact that has surfaced through processes of crossing scientific and cultural cosmologies: processes made available from a quantum reformulation of reality. *The Bulk* sculptures borrow from higher dimensional 'polytope' geometries are a way of making space and performing the higher-dimensional model of holography. As the bulk rotates slowly, attached to a mirror-ball motor, the shadow patterns on the floor drift and meander, opening onto still other readings and possibilities. These shadows were filmed on site and then reinserted into the video that is playing on the gantry crane, reiterating the media spaces through one another. The play of projecting through dimensions and the title of the installation itself of course is illuminated from *Flatland* (Abbot 1884) (TF).

53.

The natural decay of the surrounding norite rock also has to be considered in everything that SNOlab does. In this collection of objects - an *Isomorphis* digital print comprised of flattened 3D scan material of the drifts rocky surfaces is overlayed with the data from the SNOlab user manual that describes the decay chain of the naturally occurring Uranium and Thorium in the rock, the very decay processes which make the tunnels so warm, requiring vast air conditioning systems. The norite rock is lifted by a narrow band of bronze, bringing attention to it, slightly tricking gravity and gesturing towards its 'cosmotechnical' (Hui 2017) and agential status. The Scientific Director of the McDonald Institute Tony Noble uses the *Isomorphis* image now in his teaching to physics students as he believes it to lead to better understanding of the site and processes there, himself recognizing the particularization of the rock in the image as anagogical to the particle view of a physicist, even while looking at the decay chain of the norite. (PL)

54.

All of the prints in the installation and including parts of the n-Land video incorporate the grey and white checker pattern used in the Adobe Photoshop software that indicate transparency. Uncharged particles of neutrinos and dark matter are themselves invisible: because they are neutral, or without any charge, they're transparent. Though they carry energy they are of a different order of being, indicating another type of physics that has yet to be revealed. Themes of transparency and opacity play throughout the installation as well, for example, in the list of materials I also included neutrino particles, which are filling the room imperceptibly, but also with the inclusion of the Robinson-Huron Treaty which speaks to settler Canadians' indifference to the lands they're lives are based on thanks to such coercive settler documents. In the case of the annuities case in Canada, despite its significance for Anishinaabek and other Indigenous communities across Turtle Island, most settlers have never heard about it. (PL)

55.

The tapes on the floor of the n-Land exhibition also borrow from the laboratory, where tapes are used to indicate where different machines, apparatus, or detectors should be located on the floors, but are often not there, gesturing to the knowledge that something should be there, but is imperceptible. The tapes also act a s vectors of force, recalling particles traces, and rearranging the dynamism of the space. In the next iteration of this installation blue ultraviolet light will be used in a white space, rather than painting it blue and beige. Since neutrinos fluoresce an ultraviolet blue when they cause charged particles to decay faster than the speed of light, this colored light scheme will also transport the viewers into this territory of particle decay and particle detector.

5.3 Fieldwork

In November of 2018 I was invited by curator Sunny Kerr to take part in a residency and exhibition project that would allow me to visit SNOlab in Sudbury, Canada during the summer of 2019. In 2015 SNOlab was awarded a Nobel Prize in collaboration with the Japanese Super Kamiokande neutrino experiment for describing the 'oscillations' of neutrinos. The project was organized with the Arthur B. McDonald Institute of Canadian Astroparticle Physics (MI) and the Agnes Etherington Art Centre, each located at Queens University, Kingston, Ontario Canada. In collaboration with SNOlab this project promised a remarkable opportunity to enter deep into the Earth and to visit the world's deepest clean lab. There seemed to me something very profound in this opportunity, something nearly spiritual – to enter so deeply into the earth. Since I had had some significant ongoing chronic ailments, I had decided to approach the laboratory and the mine that is within a little bit lighter – without bulky and heavy camera equipment. Instead, I brought with me a small handheld gyroscopic 4k camera, my iPhone with a 3D scanning app, and a zoom audio recorder. This combination of small light equipment of course had drawbacks, but also had significant advantages for mobility and elusiveness. I was no longer capable of holding and carrying heavy equipment and tripods, so I thought the maneuverability would be a benefit, while the very small nature of the Osmo pocket camera would be less imposing to researchers, who might then be more relaxed around recording equipment.

This journey and invitation were very significant for me for a number of reasons. This was the first time in a decade, having had left my birthplace and living abroad, that I was invited back to make a significant work that will tour the country. It would allow me to go deep

into the Earth, which resonated deeply within me. I had been interested in SNOlab's detectors for nearly as long as I had been away from Canada and had dreamed of having the chance to visit. Finally, it was an invitation that came to me at a point in my research practice that I was researching anti-colonial perspectives – I was invited to Canada to make an art-science project, but I would also be able to use this opportunity to confront my own status as a settler colonial subject and go deeper into settler-Indigenous relations and engagement with Indigenous scholarship.

In summer of 2019 I travelled to Ontario and went directly to Kingston where I was introduced to the spaces of the museum where we would eventually be installing our work and visited scientists in the McDonald Institute who spoke to Dené artist Anne Riley and I about their research and experimental detectors. As a queer Indigenous artist from the Coast Salish people of western 'Canada' (or Turtle Island as it is known colloquially by Indigenous folx) Anne had some concerns with the number of white men speaking to us about mathematical realities. Later at SNOlab, the gender gap was inverted, and we spoke with and were in conversation with many women (of color). Anne decided however to only enter into the mine once, and would not return there with us, feeling traumatized by the experience of entering into what is a historical practice of exploitation and looting of Land.

To enter to SNOlab, one has to pass through an active mine, a mine that is more than a century old and which has passed through a series of various owner-operators. Now the mine is run by perhaps one of the largest most egregious mining companies *Vale:* the largest iron-ore and nickel producer in the world. In 2020 they were responsible for The Brumadinho disaster in Brazil leaving a wake of 270 dead, hundreds of kilometers of river poisoned, and

hundreds of thousands of acres of agricultural land decimated. In 2020 at a CREAM organized event with Arts Catalyst and the London Mining Network called *Assembly: Extractable Matters*, I met a man whose family had been lost in that disaster, and he had told us that Vale had not yet taken responsibility for the burst damn nor the hundreds of deaths, and that the laws around tailings damns are so lax that it will inevitably happen again. In February of 2021 the Brazilian government ordered the multinational to pay 7 billion in damages to families, while billions more of their assets were seized and a dozen other tailings sites closed. This may seem like a far digression from the trajectory of the Canadian site, but is nonetheless entangled, revealing the relationships that are in place for new knowledge of the cosmos to be revealed.

On site we were not allowed to photograph or film any part of the mine, neither above nor below ground. We were only allowed to film when we had entered the 500 meters of Drift operated by SNOlab. Later, after having had installed my new series of works, the installation n-Land, the curator and I, as well as the new director of Agnes Emelie Chhangur, had to deal with the SNOlab's irrational fears of my work and its voice in relation to the mine and its operators. SNOlab wanted to put signs next to every stone that I used in the exhibition stating that it had not come from the mine, worried that an executive or spy from the mine would come and see a rock and assume it had been taken from the mine without permission, thereby setting off a chain of events that would 'cancel' the laboratory. Similarly, I included a digital copy of the settler document, the Robinson-Huron Treaty, in both the new video and physically in the installation. They had insisted that I had to reedit the video so that the mining company would not perceive there to be any form of criticism. Their logic for this was – again – that at any moment the mining company could shut them down if they perceived any sort of threat or

criticism of their operations. This seemed completely irrational to me because the lab won a Nobel prize in 2015 for its collaborative work in describing neutrino flavor oscillation. Which is to say, to some extent, the labs' being there in the mine also contributes to the identity of the mining company, white washing it with scientific practice and knowledge. The laboratory explained to the curator and director that if I would not re-edit the video so that the discussion of the treaty and its ongoing federal annuities case were not moved, that they could not allow the exhibition to go on. There are sections in the video speaking with or to each character, agent, or layer of the laboratory that would not traditionally be described as part of the laboratory. In the original edit of the video the Robison-Huron Treaty was discussed over images of the dark mining drift tunnel. Communications officers from the lab had asked us to move the discussion away from any relation to the mine: instead over the landscape images.

SNOlab and the MI are actually harbingers in the social world of physics, with more diversity than I have witnessed in any other physics institutes anywhere in the world. They are ahead of the game, so to speak, around issues of LGBTQIA2S+ representation, and are actively working towards meaningful relationships with the local communities where they work and operate. Nonetheless, as an artist working in physics, I feel that it is my duty to situate the practice and lab within multiple dimensions of meaning. It is through accounting for the relationships between materials, agents, things, apparatuses, and bodies that we get a greater perspective on and therefore better understanding of what is at stake in the modern construction of knowledge, and the limits that these practices impose and reconfigure.

When I approach the site I have questions regarding the experimental spirit discussed earlier: how do we as researchers learn from materials? The knowledge is in the relationships between the material, the land, and the researchers practices, not solely in the researcher. So I ask, what are the conditions for the possibility of constructing these new views on reality and the cosmos, these hegemonic practices that pejoratively universalize and de-enchant the world(s). These questions inevitably lead me to the desire to understand the holographic of the site. By situating these practices in the rock, the treaty, the meteor impact, and the mine (and its toxic legacies), we begin to get a fuller understanding of what is at stake in the production of knowledge.

On site I touch and feel whatever materials I am allowed to, I let them 'speak' to me internally, using intuition, presence, and intention. I am reminded again of Campagna: (2019) "[T]he ineffable as life, constitutes a dimension that is internal to the principle of existence" (p.232). Having the ability to access that dimension through what might be called the radical sensitivity of artists and mystics is my approach. I do not claim to be a master of this, as the process depends on the time and space, the material, the land. It is always changing and ambiguous. Being open to the resonances of matters and lands, particles and other materialities and elements leads to a mutual recognition that begins to constitute a new form of practice for me. Something I have only come to in these final months of understanding and growth that I have registered through this research.

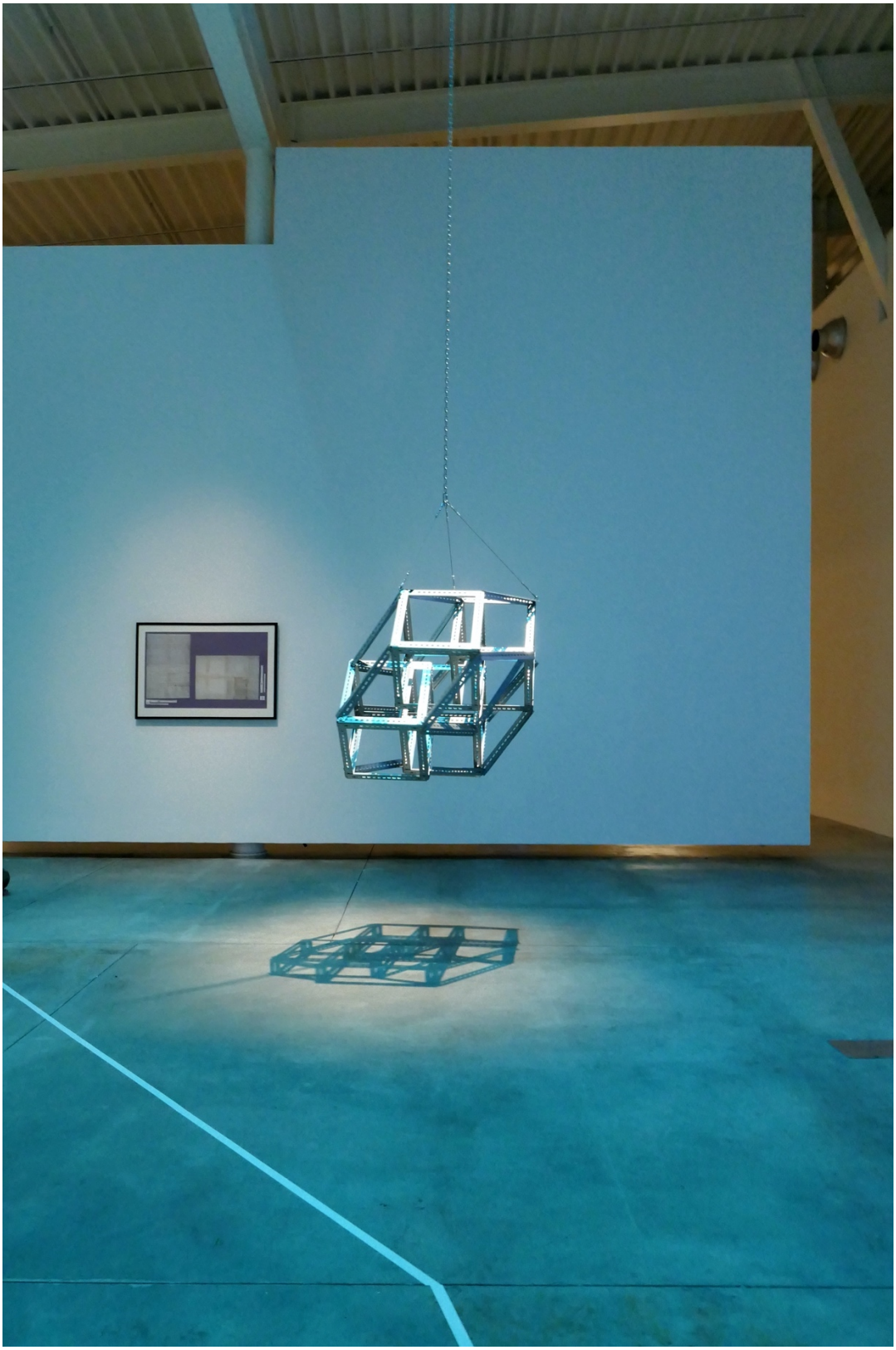
Locating scientific practices from perspectives of anti-coloniality and new materialisms offers new critical opportunities and potentials for the role of sci-art generally. I find it particularly useful in the domain of physics because this particular discipline disciplines our

Western cosmology into one of scientism and disenchantment. By relocating physics back into and of the world and materials, other ways of thinking about what knowledge is or can do, opens up to things we have still yet to describe or experience.

56. *n-Land* by Jol Thoms 2021 in the DRIFT: Art and Dark Matter touring exhibition. Belkin Art Gallery, UBC, Vancouver, Canada.

57. *n-Land* by Jol Thoms 2021 in the DRIFT: Art and Dark Matter touring exhibition. Belkin Art Gallery, UBC, Vancouver, Canada.

58. *n-Land* by Jol Thoms 2021 in the DRIFT: Art and Dark Matter touring exhibition. Belkin Art Gallery, UBC, Vancouver, Canada.



59. *n-Land* by Jol Thoms 2021 in the DRIFT: Art and Dark Matter touring exhibition. Belkin Art Gallery, UBC, Vancouver, Canada.

Chapter 6

Conclusions: A Holographers view

60. *n-Land* (4K still image) 2021, quote from Bronislaw Szerszynski and Nigel Clark's 'Planetary Social Thought' (2020)

"No wonder! No wonder that our sophisticated civilizations, brimming with the accumulated knowledge of so many traditions, continue to flatten and dismember every part of the breathing earth … *For we have written all of these wisdoms down on the page*, effectively divorcing these many teachings from the living land that once held and embodied these teachings. Once inscribed on the page, all this wisdom seemed to have an exclusively human provenance. Illumination—once offered by the moon's dance in and out of the clouds, or by the dazzle of the sunlight on the wind-rippled surface of mountain tarn—was now set down in an unchanging form."

(Abrams, 2010, p.281)

6.1 The phase-space of Lands ancient mind

In the introduction to the Unangax̂ scholar Eve Tuck's *Critical Place Theory* (2014) they include geographer David Harvey's observation: "How we represent space and time in theory matters, because it affects how we and others interpret and then act with respect to the world" (Harvey, 1989 p. 205 quoted in Tuck 2014, p.1). What I have developed over the course of my research practice with holography as a critical concept and process informed from feminist postcolonial science studies and art practices is a contribution to (re)thinking place(s) in their multiplicities, accounting for more of their characters, histories, continuities, differences, boundaries, and voices for a more plural and multivocal understanding of experience and reality, as well as for an understanding of the conditions for the possibility of knowledge. This has the double action capability to update some of the stories told around scientific methods and achievements, situating them in times/space/matter - grounding them - while keeping their wonder alive: remaining *far-out*. Again, the holographic is not just a creative tool for coding and decoding complex information and reciprocities in/of environments, but also for understanding and recognizing value(s). I have suggested that this holographic metamodel, this critical interferometry, can affect how we think about and comport ourselves with/in and as nature.

> "If we are to alter and explore a more robust version of reality then here is where our suspension of disbelief can be practiced. Here is where faith in wholeness and interconnection is rigorously definitive. Here is where indigenous realities, contexts and understandings can benefit from cross fertilization with Western classical sciences because a hologram is made with modern techniques but its implications are best

understood with an ancient mind: *The whole is contained in all its parts*." (Meyer, 2013, p.94)

The concept of the holographic, a laser-photographic phenomena developed in the early 1960's was introduced in anthropology by Roy Wagner in the 1980's as a way to think the process and object of a hologram, its unique quantum properties, as an analogous tool for western anthropologists to understand some non-western modes of understanding – about place and ecology, about interconnection and interdependence. The holographic as I've traced through this written and artistic work offers a *volumetric* model for thought and place, rather than merely an optical metaphor of either reflection or diffraction. The thought that place has, and accounting for that phenomena within entangled cosmologies of the third millennium is a significant contribution to the ongoing reformulation of western epistemic practices. In fields as diverse as political economy, geopolitics, cognitive theory, cultural anthropology, criminology, science studies, physical cosmology, and others, quantum holography is taking on new shapes and possibilities for thinking the complexities of the modern world.[45]

It is important to again reiterate that a hologram is itself built up of interference patterns, or diffractions themselves. The holographic transcoding and isomorphic projecting, its intra-scalar maneuvering and methods in, through, and *as* the bulk of higher or multiple dimensional spaces, brings us tools of accountability by offering renewed perspectives on what is included in the

[45] See, for example: Pan, C. (2018). Toward a new relational ontology in global politics: China's rise as holographic transition. *International Relations of the Asia-Pacific*, *18*(3), 339-367; Pitts, M. E. (1990). The holographic paradigm: A new model for the study of literature and science. *Modern Language Studies*, 80-89. Milovanovic, D. (2013). Quantum Holographic Critical Criminology. *Journal of Theoretical & Philosophical Criminology*, *5*(2); Plate, T. A. (2003). Holographic Reduced Representation: Distributed representation for cognitive structures.

production of various accounts in specific epistemic practices. While the complex notion and method of diffraction from Barad remains incomparable in theoretical work, the critical interferometry of the holographic is more attuned to working in artistic spaces and landscape-laboratory places because it opens to the excessive, the more-than, the agential, and the entitative which can be exceptionally generative for de/familiarizing theory, concepts, sites, minerals, forces, imperceptible phenomena, writing, building, installing, discussing.

In the age of severe climate breakdown, where each year is the hottest on record, when the Ocean is literally on fire, and football fields of forest are being burned or torn down *by the second*, to suggest that it is important to update our thoughts and concepts of nature, being, technology, and life, seems almost beside the point.[46] We need action, commitment, organization, voice, and power; we request and require collaboration, connectivity, and aesthetic practices geared for the challenges. But to move forward, to consider what is necessary for the coming generations to have some semblance of health and agricultural security, it is imperative to come up with new concepts, practices, idea's, performances, dances, poems, logics, songs, foods. The holographic contributes to that thrust by avoiding 'coarse-graining'; by considering the politics of location in/and situating practices; thinking in and beyond multiple scales and temporalities; and in using counter-allegory to understand the politics and histories of scientific practices. Scientific practices are necessary to find solutions to our deep problems in the material realms of existence but are completely unsuited for our

[46] This is being written in a perverse era, when a young Greta Thunberg can lambast entire conferences filled of politicians to their face for paying lip-service to the calamitous situation of global energy and climate infrastructure, and they will applaud her, making no changes. See: https://www.independent.co.uk/climate-change/news/greta-thunberg-speech-today-schwarzenegger-b1876246.html . This while quite literally the Gulf of Mexico was *on fire*. Creating a spectacular science fiction like image for human spectacle-thanatic enjoyment .See: https://www.independent.co.uk/climate-change/news/gulf-mexico-oil-pipeline-fire-b1878558.html

spiritual and emotional existences. As John Latham wrote: “Physics, which uses a dimensionality that could do so, is nevertheless unable to move outside its particular boundaries and refer in any way to sources of human action”(1963, np). Science can tell a good story, but not the only story. There are relevant ways to (re)think and re-link qualitative and quantitative practices.

Over the course of this personal process and experience I have become an holographer, a practitioner that acknowledges the wisdom of the Land, that is willing to be led by it, which in turn requires something akin to *Deep Listening* ™ of Pauline Oliveros (2005), as well as intuition and expanded ‘proprioceptive’ sensitivity, meaning a heightened awareness of one’s body, joints and limbs (but where one’s body is not defined by the skin barrier, but rather is a promiscuous and licentious body that is as much insect and tree, as particle or wave – as much the environment as the thinker believing herself an individual separated from it). My journey through Siberia, Fusion reactors, mines, and dark matter labs; my journey through the institutions of science and academia, through texts and discussions, and the dreams which have informed so much of my practice, have dropped me, carefully, into this very moment of transformation. Here, shedding skins, epistemes, outdated and inadequate practices, I am able to articulate my journey through the development of my art works.

This thesis has been a slow burning and, at times, excessively theoretical engagement. I understand that as a creative-researcher this is not what was necessarily expected or even desired from me, but generally I am a person, for better or worse, who upsets (and/or exceeds) expectations. Theoretical and historical analysis was a significant part of my holographic development which has supported this counter-method. Through encounter and collaboration

with international scientific experiments and analysis of the origins of scientific cosmology and Western metaphysics, I have learned, grown, and transformed my practice into this explicit hyperdimensional phase-space orientation. To me this language and grammar is important because it appropriates the technology for something leading to ecosocial justice. After many years working, talking, dining, speculating, and gaining trust with collaborators and partners at the Technical University of Munich, I was offered a space aboard their Pacific Ocean neutrino telescope experiment 'P-ONE' (Pacific Ocean Neutrino Experiment). Since 2011 I had dreamed of working directly with such a telescope, perhaps being reminded of Walter de Maria's *Lightning Field,* and other canonical land art works. For nearly a decade I had been considering interesting ways to interfere with, hijack, or collaborate in or as a neutrino telescope – buried, imperceptible, massive potential – an artwork on the scale of cubic kilometers, buried in the Antarctic, for example, unvisible by humans, taking up a mere fraction of a fraction of a second perhaps.

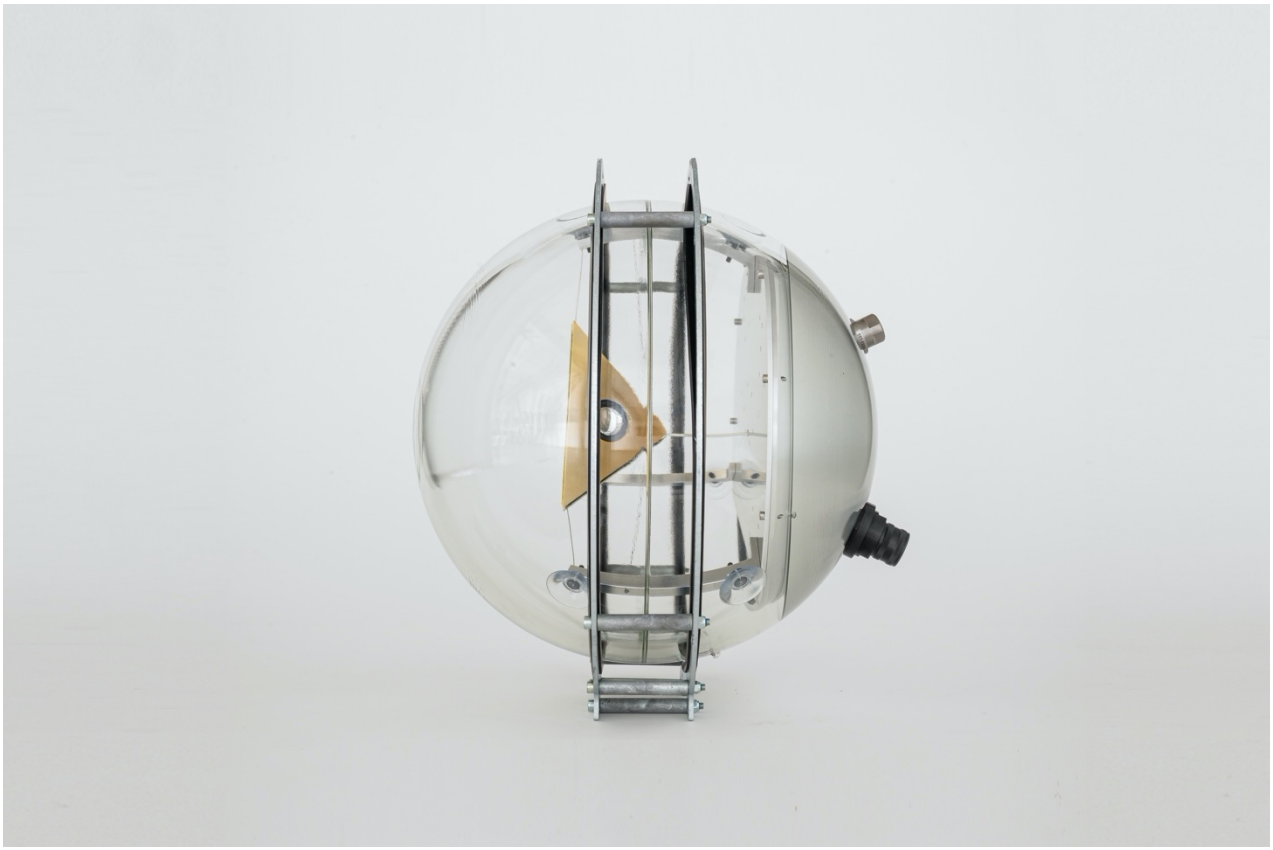
With the invitation from my friend and colleague Elisa Resconi, I was offered a single glass sphere to contribute art, or make an exhibition, 2.5 kilometers deep in the Pacific Ocean aboard their newly deployed telescope. You might recall the image of such a glass sphere from Chapter 3 (p.95). You will recall that these types of observatories are vast matrixial arrays of thousands of such spheres embedded in planetary bodies. Well, the invitation from Elisa came in early 2019, the message was clear: they are beginning to test and develop the likelihood of Cascadia Basin for the world's first Ocean neutrino telescope.[47] Cascadia Basin is accessible due to a collaboration

[47] The very first neutrino telescope experiment 'DUMAND' was meant to be in the Pacific Ocean, off the coast of Hawaii and 5 kms underwater, but on first attempt to submerge equipment, scientists quickly cancelled and rethought their idea. It was not possible to safely get the optical equipment into the water. Later, the first large scale observatory was instead embedded in the ice of Antarctica, and which has been invoked earlier: IceCube. The ice of course offering a calm stability that the vagaries of the Ocean does not, though of course coming with its own dynamic challenges.

with a vast underwater oceanographic and marine monitoring network: *Ocean Networks Canada*. Therefore, an infrastructure already exists with which to ship, deploy, submerge, and maintain a vast underwater telescope that peers deeply into the waters of Earth to find and reconstruct the superluminal intra-actions of neutral neutrino particles within the baryonic matters of Earth.

Surprised by the invitation and opportunity, I was unable to immediately think of a relevant thing to do. It took a lot of thought and distractions to eventually find my way, through an *aha!* moment to the project *Radio Amnion: Sonic Transmissions of Care with/in Oceanic Space.* Here, with Radio Amnion, all of the aforementioned thoughts, considerations, trajectories, all align into a sound-art for the Ocean project that invites and commissions, thanks to support from the Canada Arts Council, many different practitioners, positions, and voices to participate in this unprecedented series of overlaying projects (oceanographic, cosmological, artistic).

It happened that I was offered an opportunity to do something 300 kms from the shores of Vancouver Island, 2.6 kms underwater, in a zone that flattens and expands spacetime, where oceanography and physical cosmology meet deep space, deep history - and the only thing I could consider was how to share and open the access to other people who wouldn't normally have access to these places. Finally, it occurred to me: I can *invite* people to send messages, soundings, and voicings deep into, and crucially *for* the Ocean itself - *if* I design a networked sound sculpture for the sea. 2.5 years later, the project has finally begun transmitting, with the first commissioned work by Libita Sibungu and Perivi Katjavivi being transmitted underwater and on the dedicated website co-designed with Minkyoung Kim and Marie Otsuka: https://radioamnion.net during the first full moon of the northern hemispheres summer: June 24-26, 2021.



61. *Radio Amnion.* Jol Thoms (2020). Optical Glass, Steel, Rubber, Aluminum, Plastic, Brass, Electronics.

Radio Amnion foregrounds underrepresented voices and practices in art-science and operates in the nonhuman/spiritual realm while still being attached to large scientific institutions' sensing arrays. The fact that this project was accepted and is celebrated by the institutions involved, I believe, speaks to the necessity for long-term engagements and commitments in art-science relationships and collaborations, while also revealing the degree to which scientific concern for the environment again reveals the need for *new stories* and new modes of address. It takes a lot of trust, care, and knowing one another to be able to come up with, develop, and deploy such a project.

The first cycle of lunar commissions also include: Abbas Zahedi, Margarida Mendes, Samuel Hertz, Caitlin Berrigan, Andrea Zarza, Josèfa Ntjam, Nicole L'Huillier, Tuomas A. Laitinen, and Analisa Teachworth, with a contribution from ocean-art institution TBA21|Academy and the collective DARK MORPH (Jònsi of Sigur Ros and CM von Hauswolff).

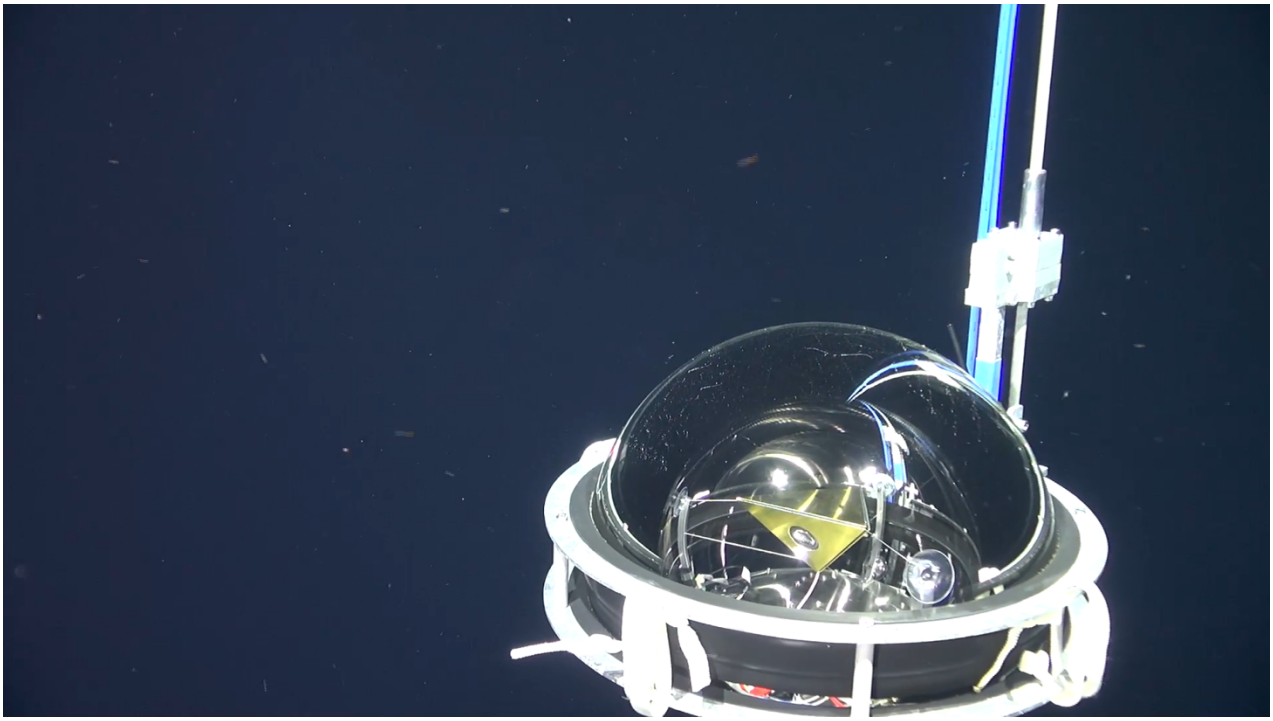
> "The "nature" of our bodily water is meaningful and meaning-making, just as the porosity, fluidity and leakiness of our selves are no mere metaphors. Our bodies have cultural or social meaning not despite their wateriness, but rather because of and through their watery constitution: water animates our limbs, expresses our emotions, enables our reproductive proliferation. But moreover, our bodies of water open up to and intertwine with the other bodies of water with whom we share this planet". (Neimanis, 2009, p.182)

The hydrological cycles of Earth allow elemental waters to meander over aeons through rock, sky, plant, and animal, as cloud, blood, saliva, river. Water has played crucial roles in rituals from diverse cultures: cleansing, healing, vivifying. *Radio Amnions* newly commissioned soundings, laments, voicings & incantations enter quietly into these ancestral terrains: into memories, shapes, and phases, multiplying the underlying commitments and intentions of the most sacred force and technology of organismic and planetary life – *water*.

In the 21st century the vulnerability of planetary water bodies, indeed of many forms of life which are themselves precarious bodies of water, is more apparent than ever before. While sea levels are rising faster than scientists' worst models have predicted, vast anoxic 'dead zones' are swelling, and clean water is becoming scarcer due to centuries of industrial pollution and

mismanagement. The multi-year deep sea sound-art project *Radio Amnion* commissions new sound works from artists and researchers interested in sending soundings and voicings of care, affirmation, and gratitude directly in/to and for the Ocean itself, the waters that sustain life.

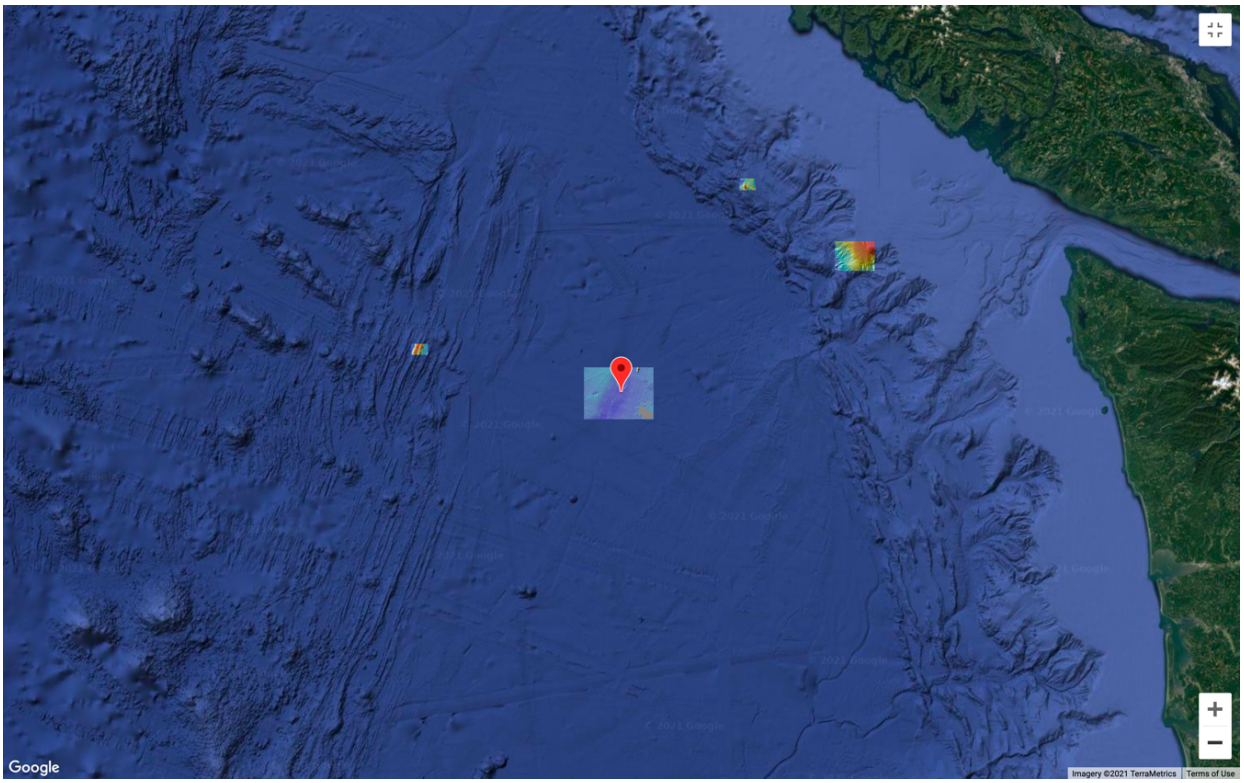
These new transmissions from critical emerging artists, musicians and researchers are relayed 2.6 kms deep into Cascadia Basin of the Pacific Ocean during each full moon. Composed for and played directly in/to the waters that irrigate and connect all forms of life on planet Earth. *Radio Amnion* acts as an enquiry into Ocean stewardship, climate responsibility, contemporary mysticism and ritual, as well as sonic practices of healing and resilience. This eco-cosmo-logical sound art project for the celestial sea is also available to engage with online at https://radioamnion.net allowing for real-time resonance with the deep oceanic transmissions. During each forthcoming full moon Radio Amnion will release a new 'transmit' and visitors will have the days that bracket the full moons to explore the archive as it swells, ebbs, and flows.



62. *Radio Amnion* in situ (-2370 meters). Jol Thoms. Image by Hercules ROV. (2020).

The Radio Amnion Sonic Platform is attached to a submerged multi-cubic kilometer 'neutrino telescope' (a complex matrixial array of optical modules) being developed by the Technical University of Munich's 'Neutrino and Dark Matter Group' (SFB1258). Thanks to the vision and vivacity of Prof. Elisa Resconi, the group's leader, *Radio Amnion* has been invited into this atypical zone of possibility that strangely embraces cosmological and Ocean sciences as well as the arts and their relations to the intangible and ineffable. This is what gives the project a sense of urgency for me. There are two vast scientific institutions and practices of sensing earth and cosmos, water and imperceptible particle, and they've agreed to and celebrate a project which reaches beyond measurement and quantification. A shared story can emerge, a continuum is being felt out and bridged between diverse and traditionally opposing cosmologies. But there, deep under water where vast reaches of the galaxy are sensed within the Earth, shamanic journeys also emanate. This is a spacetime continuum collapse and expansion that matters and matters, that spirits and enspirits.

The ‘P-ONE’ telescope of Resconi is deployed 300 kms from the shores of Vancouver Island attached to the unique 800 km underwater network of marine and oceanographic monitoring stations, the ‘NEPTUNE Observatory’ of Ocean Networks Canada a University of Victoria, BC project in Canada. The very fact that this telescope that embraces distant cosmic events is placed deep within the open Ocean makes explicit the truly radical relationality of space and time offering us a significant and distinctive vision of connectivity in times of division and isolation. Simultaneously artists who may not have had access to such terrains are offered this chance to send their soundings and voicings, into these sites existing outside of reason, inside of eco-cosmological conditions that are being traced and grooved by consortiums of artist-scientists.



63. Pacific Location of the Radio Amnion Sonic Platform, Cascadia Basin node of Ocean Networks Canada’s NEPTUNE Observatory and site of the P-ONE Neutrino Telescope.

6.2 To Be Continuum

> "A modern "ecosophy" would be about the rediscovery of meaning as it relates to our universe. It would require not only a different way of thinking, but also a different way of knowing and living. Such an ecosophy would build a unitary view of the cosmos in which everything is interdependent and moved by creative energy, one that views the Earth and the universe with reverence and explores our essential relationships and responsibilities there in. It would be, essentially, the philosophy Indigenous people have lived for generations". (Cajete, 2000, p.60)

The construction, articulation, maintenance, and imposition of an indifferent/unknowing universe leads people astray, towards anti-environment behaviors, extractivism, and spiritual voids, away from community and collective. I know this because I have also been led there in my life and experience, but over the course of my research I have returned to what is meaningful and valuable, beyond scientific materialism - though not excluding it - but desiring it to open back up to the world and its polyphonies. With *Radio Amnion's* ritualistic relays on the full moons (for at least the next year), artists communing with the Ocean aboard a network of oceanographic and cosmological observatories, collapses exclusive cosmologies towards something different, something holographic and mystical, reinserting the ambiguities and contingencies of experience within relevant channels of sense. A holographic worldview might be still far away from where I have arrived, but with the beginning of Radio Amnion in June 2021, a new chapter of my research and life has opened up, and it took the course of this PhD

to get t/here, through diversions, tactics, schemes, theorizations, excesses, situating, illness, counter-allegory, meditation, fatigue, devastation, alchemy, physics, chronic pain, collaboration, failure, nerves, and magic.

Questions that remain open for me, and that will feed into my changing and evolving practice are: how can we (re)approach land as *L*and? What are the respectful, humble, calm, and courteous ways to enter a forest, the sea, a desert, or mountain? What practices of communing do we need to (re)invent to practice #earthcare for our wise places? How as artists and practitioners can we expose, display, argue for these necessities? I am currently getting more and more interested in dance and vocal performances, practices of radical empathy/love and presence that reveal deep respect and appreciation for the beings of this planet.

Many art-science collaborations and practices are far being able to negotiate the histories of epistemic violence inherent to the tradition. There is still work to do and undo, and it's a project that likely will not have an end. I've learned to choose well my collaborators before embarking on year-long processes, I've learned to ask physicists to preamble their sentences with, "as a physicist I believe….". There are limits within the art-science discourse, but with careful, knowledgeable, durational collaborations, new alleys and avenues present themselves. I will continue to tread that line and find those grooves within which to bring critique, awe, and wonder.

> "Finally, it is not clear what formal institutional channel would transmit quantum ideas into associations and therefore international politics… In the 20th century, the cybernetic systems model from physics and engineering entered via economics. In the nineteenth

> century, Darwinian and geological ideas entered through social anthropology. In the eighteenth century, political economy transposed materialism, mechanism, and measure into growing state bureaucracies. But in the case of quantum mechanics, no politically embedded transnational network has taken up and pressed quantum ideas into political discourses" (Allan, 2018, p.269).

It could be the realm of artistic research in the histories and philosophies of sciences that can attend to this line of questioning from Allan, similar questions many physicists, dancers, theorists, psychologists, and others ask themselves. It took about 300 years for the full thrust of the Galilean-Copernican revolution to play out. In the 21st century, we're about 100 years into this new statistical quantum understanding of the oscillating, promiscuous universe. Indigenous philosophers have found deep resonances with the findings of quantum mechanics, specifically the elements that connect us to the world and universe, that animate and give it the dynamism of Life. "These theories [of] quantum physics,' writes Gregory Cajete in *Native Science,*

> "have brought Western science closer to understanding nature as native peoples have always understood it – that is, not simply as a collection of objects, but rather as a dynamic ever-flowing river of creation inseparable from our own perceptions, the creative center from which we and everything else have come to and to which we always return" (Cajete, 2000, p.48).

Since I grew up in the countryside, a deep rural riverside surrounded by farmers' fields and forests – a spirited land – I have always felt deep connections with the rocks, waters, and trees. I recognize myself in them, and they in return. But I lose and miss these realities when in cities. I am working to regain my knowledge, the knowledge that I intuitively express when in remote lands. How to be present in these places is not something that is generally taught. But they are sites of profound strength and knowledge. My future orientation is to find ways of sharing processes for others to find their own contingent, site-specific methods for connecting to places, entities and forces of Land. I still have a lot of learning to do myself, but I feel that these resources can be honed, stored, and maintained for strengthening the communities of resistance we see developing in (admittedly troubled) movements like Extinction Rebellion and Fridays for Future. Surely new communities will grow, emerge, and resist the fallacies of the modern West. It is towards those spirits that I direct my new inquiries, where I find unresolved challenges and inspirations.

This thesis has become an elaboration of the holographic and asks key questions: As a volumetric form of thought, what does the holographic offer for thinking, reading, and feeling the multiplicity and plurality of Land? How does holographic engagement enable us to value the mystical or ineffable alongside the calculable and measurable? Can it help us hold these two worldviews simultaneously – co-presently? If scientific knowledge is our best hope for diagnosing the planet's health, for thinking its livable futures, responding considerately to its ills, capital 'S' Science (Stengers 2018) itself needs to undergo some significant internal reconstruction and reorganization, perhaps starting with the stories it tells (of itself).

By thinking with environmental humanities, critical histories and philosophies of science, anti- and de-colonial thought, all coming essentially from feminist scholarship perspectives, I have developed new bodies of artwork as case studies for critical scholarship that contributes to these ongoing, ever evolving institutional critiques of western epistemology and ontology. Through theoretical analysis and the experimental spirit that allows me to learn from any material or landscape I have further developed the concept of 'the holographic' as a volumetric, multidimensional tool for thinking, reading, writing, and feeling the multi-scalar, multi-temporal pluralities of lived and endured place, site, and Land. Through this critical interferometric approach I have emerged into a universe of negotiation where what might be called 'the mystical' can equally live alongside the calculative, measured, scientific 'real' – a continuum of the in/tangible and im/measurable that offers new modes of address and responsible consideration. In an age of cosmological upheaval such as this, this final breakthrough is a rich possibility for critical storytelling, mythmaking, and collective worldbuilding that Earth requires if it is to host a healthier, embedded, responsible civilization, capable of weathering the coming and ongoing storms.

In Lola Olufemi's (2021) radical *Experiments In Imagining Otherwise*, we fall down a well of unknowable infinity together, through the chaos of imagination as generative of resistance and renewal. In the dedication to that incredible work she writes, "I promise to keep opening up this world until the next one comes into view; to make it habitable for us and everyone else" (np). My experimental theory/practice of the holographic also aims to open up the world, to uncover it, to eventually make it more habitable through accountability.

Quantum Ecologies reveals links between Indigenous philosophy and philosophies of science, bridging divides between the im/measurable, crossing cosmologies. Through the holographic approach I've shown how what we refer to as science could, alternatively, also be understood as a highly advanced form of magic (rooted as it is in those alchemical traditions coming from the 11th century *Picatrix).*[48] By thinking with magic, the ineffable, and the intangible, as well as with phenomena such as synchronicity, the holographic is able to account for and respond to some of the voices that go misunderstood or are underrepresented in scientific paradigms and institutions. This includes human and more-than-human beings and entities, it includes Land, meteor, mineral, lake, iceshelf, and mountain. But it also includes racialized and exploited human bodies. While my practice is densely entangled with Quantum Field Theory, it nevertheless holds the com/possibility that we can reformulate our notions of reality with/in a continuum of understandable and responsible engagement. This repositioning of the continuum as (a site of) power is inherent to the holographic that undermines dominant modern discourse in favor of a radically plural polyphony.

With resonances between nonhuman agency in science fiction and Indigenous philosophy of place I've furthered a framework for thinking beyond the limits of new materialism's concerns with other-than-human agency towards the already lived phase space that exists regardless of European institutional acceptance. That deep space of the intangible that exists beyond the container of western concepts of space, time, and bodies allows us to travel towards renewed modes thinking, describing, and living.

[48] Picatrix is an 11th century manuscript or handbook of talismanic magic that is suggested to have the first hint of something akin to a scientific method. See: Pingree, D. (1980).

I've borrowed from and mutated physics' own concepts and tools to situate and ground it in materials, bodies, elements, histories, and places. This brings the disciplines onto-epistemic domain closer to Earth, grounding it – disassembling the 'partial perspective' of the 'Gods Eye View' to understand it's functioning also as a cultural practice, the very practice that defines the 'scientific cosmology' of western modernity. Accounting for the more-than of physics sites asks us to rethink the telling of science itself, necessarily operating on metaphysics. In *A Borderline Conception…* (2018), Wolfgang Pauli and Carl Jung meet over a deep resonance with the 'psycho-physical' problem(s) of synchronicity and the 'Copenhagen Interpretation' of quantum physics. From Hildegard of Bingen, through to Stanislaw Lem, Gregory Cajete, Eve Tuck, Karen Barad, Andre Tarkovsky, Oscar Santillan, and others, I've shown that indeed, the quantum meta/physics of western modernity is being radically challenged by its own epistemic things, the entities physicists are lured by. Their most experimental infrastructures undermine and rewrite their own stories. From the wicked problem of plasmatic fusion energy through to anarchic neutrinos and their dark matter kin, these elusive energies and forces bypass and transcend technical and observational capacity, driving the creativity of physicists into stranger and stranger comportments, queering concepts of nature, agency, boundary, cosmos, and the human. Art as a ludic and serious process of defamiliarization challenges the norms of traditional concepts to uncover alien intelligences in the process of making themselves known, bringing diverse discourses and their knowledges together-apart, the *aufhebung* of what makes life interesting: difference.

7. Bibliography

Abbot, E. (1884). *Flatland.* Seeley & Co.

Abram, D. (2010) *Becoming Animal: An Earthly Cosmology.* New York: Vintage.

Albert, B., Kopenawa, D., & Elliot, N. (2013). *The falling sky: words of a Yanomami shaman*. Belknap Press of Harvard University Press.

Allan, B. B. (2018). *Scientific cosmology and international orders* (Vol. 147). Cambridge University Press.

Allora & Calzadilla. (2014) *The Great Silence.* https://vimeo.com/195588827 (accessed October 10, 2017)

Atmanspacher, H., & Fuchs, C. A. (2017). *The Pauli-Jung conjecture and its impact today*. Andrews UK Limited.

Badiou, A. (2011). *Second manifesto for philosophy*. Polity.

Bakke, M. (2017). Art and Metabolic Force in Deep Time Environments. *Environmental Philosophy*, *14*(1), 41-59.

Balona, A & Lemos, S. (Eds.) (2019). *Metabolic Rifts.* ATLAS Projectos.

Balsam, E. & Peleg, H. Eds (2016) *Documentary Across Disciplines.* Haus der Kulturen der Wellt Publishing.

Banerji, D., & Paranjape, M. R. (2016). The critical turn in posthumanism and postcolonial interventions. In *Critical posthumanism and planetary futures* (pp. 1-10). Springer, New Delhi.

Barad, K. (2007). *Meeting the universe halfway: Quantum physics and the entanglement of matter and meaning*. Duke University Press.

Barad, K. (2015). Transmaterialities: Trans*/matter/realities and queer political imaginings. *GLQ: A Journal of Lesbian and Gay Studies*, *21*(2-3), 387-422.

Barad, K. (1996). Meeting the universe halfway: Realism and social constructivism without contradiction. In *Feminism, science, and the philosophy of science* (pp. 161-194). Springer, Dordrecht.

Barad, K. (2003). Posthumanist performativity: Toward an understanding of how matter comes to matter. *Signs: Journal of women in culture and society*, *28*(3), 801-831.

Barad, K. (2010). Quantum entanglements and hauntological relations of inheritance: Dis/continuities, spacetime enfoldings, and justice-to-come. *Derrida Today*, *3*(2), 240-268.

Barad, K. (2011). Nature's queer performativity. *Qui Parle: Critical Humanities and Social Sciences*, *19*(2), 121-158.

Barad, K. (2012). On touching—The inhuman that therefore I am. *differences*, *23*(3), 206-223.

Barad, K. (1998). Getting real: Technoscientific practices and the materialization of reality. *Differences: A journal of feminist cultural studies*, *10*(2), 87-91.

Barad, K. (2014). Diffracting diffraction: Cutting together-apart. *Parallax*, *20*(3), 168-187.

Barker, T., & McKeown, C. (2015). Unearthing Techno-Ecology. *Digital Culture & Society*, *1*(1), 21-38.

Barry, A., Born, G., & Weszkalnys, G. (2008). Logics of interdisciplinarity. *Economy and Society*, *37*(1), 20-49.

Behnke, C., Kastelan, C., Knoll, V., & Wuggenig, U. (Eds.). (2015). *Art in the Periphery of the Center*. Sternberg Press.

Bobbette, A., & Donovan, A. (Eds.). (2018). *Political geology: Active stratigraphies and the making of life*. Springer.

Bogost, I. (2012). *Alien phenomenology, or, what it's like to be a thing*. U of Minnesota Press.

Bohr, N. (2010). *Atomic physics and human knowledge*. Courier Dover Publications.

Boucher, F. (unpublished) "On the Use of the Word 'Code' by a Kogi Translator (an eccentric account)".

Boym, S. (1996). Estrangement as a lifestyle: Shklovsky and Brodsky. *Poetics Today*, 511-530.

Boym, S. (2005). Poetics and politics of estrangement: Victor Shklovsky and Hannah Arendt. *Poetics Today*, *26*(4), 581-611.

Bratton, B. H. (2016). *The stack: On software and sovereignty*. MIT press.

Braidotti, R. (2011). *Nomadic theory: the portable Rosi Braidotti*. Columbia University Press.

Braidotti, R. (2013). *The Posthuman*. Cambridge: Polity.

Braidotti, R. (2019). *Posthuman Knowledge*. Cambridge: Polity.

Bresson, R. (2016). *Notes on the Cinematograph*. New York Review of Books.

Breyfogle, Nicholas B. "At the watershed: 1958 and the beginnings of Lake Baikal environmentalism." *Slavonic & East European Review* 93, no. 1 (2015): 147-180.

Breyfogle, Nicholas. "Sacred waters: The spiritual world of Lake Baikal." In *Meanings and Values of Water in Russian Culture*, pp. 48-66. Routledge, 2016.

Burnham, J. (1969). *Beyond Modern Sculpture.*

Burnham, J. (1968). Systems esthetics. *Artforum*, *7*(1), 30-35.

Campagna, F. (2018). *Technic and Magic: The reconstruction of reality*. Bloomsbury.

Carpenter, E. (2016). *The nuclear culture source book*. Black Dog Publishing.

Cajete, G. (2000). *Native science: Natural laws of interdependence*. Santa Fe, NM: Clear Light Publishers.

Césaire, A. (2001). *Discourse on colonialism*. NYU Press.

Charriere, J. (2018). *As We Used To Float.* Gasag Kunstpreis 2018. K. Verlag, Berlin.

Christian, D. (2011). *Maps of time: An introduction to big history* (Vol. 2). University of California Press.

Clark, N., & Szerszynski, B. (2020). *Planetary social thought: The Anthropocene challenge to the social sciences*. John Wiley & Sons.

Country, B., Wright, S., Suchet-Pearson, S., Lloyd, K., Burarrwanga, L., Ganambarr, R., ... & Maymuru, D. (2015). Working with and learning from Country: decentring human authority. *Cultural geographies*, *22*(2), 269-283.

Cox, C., Jaskey, J., & Malik, S. (2015). *Realism Materialism Art*. Sternberg Press/Center for Curatorial Studies Bard College.

Dartnell, L. (2014). *The knowledge: How to rebuild our world from scratch*. Random House.

Da Silva, D. F. (2017). 1 (life)÷ 0 (blackness)=∞−∞ or∞/∞: On Matter Beyond the Equation of Value. *Re-visiones*, (7).

Da Silva, D.F. (2018). *In the Raw.* E-flux. https://www.e-flux.com/journal/93/215795/in-the-raw/ (Accessed Mar. 23, 2019)

Da Silva, D. F. (2014). Toward a Black Feminist Poethics: The quest(ion) of Blackness Toward the End of the World. *The Black Scholar*, *44*(2), 81-97.

Da Silva, D. F. (2016). On Difference without Separability. *Incerteza Viva: 32nd Bienal de São Paulo, eds. Jochen Volz and Júlia Rebouças (São Paulo: Fundação Bienal de São Paulo, 2016)*, 57-65.

Da Silva, D. F. (2021). *Drift: Art and Dark Matter* opening conversation between Jol Thoms and Denise Ferreira da Silva. The Morris and Helen Belkin Art Gallery, University of British Columbia, Vancouver.

Davies, G. (2010). *Where do experiments end*? Geoforum, 41(5), 667-670.

Davis, H., & Turpin, E. (2015). *Art in the Anthropocene: Encounters among aesthetics, politics, environments and epistemologies*. Open Humanities Press.

Davis, H. (2018) *Bad Star.* Canadian Art. https://canadianart.ca/essays/christina-battle-bad-stars/ (accessed Apr 10, 2019)

De Castro, E. B. V. (2004). Exchanging perspectives: the transformation of objects into subjects in Amerindian ontologies. *Common knowledge*, *10*(3), 463-484.

De Castro, E. B. V. (2015). The Relative Native: Essays on Indigenous Conceptual Worlds. Chicago: HAU Books.

Deere, D. T. (2020). The Spacing of Decolonial Aesthetics. *Journal of World Philosophies*, *5*, 89-98.

De La Cadena, M. & Blaser, M. Eds (2018). *A World of Many Worlds*. Duke University Press

DeLanda, M. (2007). Matter Matters. DOMUS magazine.

Deleuze, G., & Guattari, F. (2014). *What is philosophy?* Columbia University Press.

DeLoughrey, E. M. (2019). *Allegories of the Anthropocene*. Duke University Press.

Demos, T. J. (2017). *Against the Anthropocene: Visual Culture and Environment Today*. Sternberg Press.

Demos, T. J. (2016). *Decolonizing nature: contemporary art and the politics of ecology*. Sternberg Press.

Demos, T. J. (2015). *Rights of Nature: The Art and Politics of Earth Jurisprudence*. Santa Cruz University.

Demos, T. J. (2009). The politics of sustainability: art and ecology. *Radical nature: art and architecture for a changing planet*. 17-30.

Demos, T. J. (2013). Contemporary Art and the Politics of Ecology: An Introduction. *Third Text*, *27*(1), 1-9.

Denzin, N. K., Lincoln, Y. S., & Smith, L. T. (Eds.). (2008). *Handbook of critical and indigenous methodologies*. Sage.

Despret, V. & Meuret, M. (2016). Cosmoecological sheep and the arts of living on a damaged planet.

Despret, V. (2013). From secret agents to interagency. *History and Theory*, *52*(4), 29-44.

Dewsbury, J. D. (2011). The Deleuze-Guattarian assemblage: plastic habits. *Area*, *43*(2), 148-153.

Diawara, M. (2014). Glissants Worldmentality: An intorduction to *One World in Relation*. http://www.documenta14.de/en/south/34_edouard_glissant_s_worldmentality_an_introduction_to_one_world_in_relation (accessed Mar. 15 2018).

Dobiey, D & Helmert, C 2015. *Age of Artists, Interview with Hans-Jorg Rheinberger* http://www.ageofartists.org/aspect-activity-interview-hans-jorg-rheinberger/ (Accessed Nov 24, 2017)

Einfeldt, K., & Wolf, D. (2017). *Reverse Hallucinations in the Archipelago*. A. S. Springer, & E. Turpin (Eds.). Haus der Kulturen der Welt.

Engelmann, S., & McCormack, D. (2021). Elemental worlds: Specificities, exposures, alchemies. *Progress in Human Geography*.

Engelmann, S. (2020). *Sensing Art in the Atmosphere: Elemental Lures and Aerosolar Practices*. Routledge.

Fanon, F. (2001). *The wretched of the earth*. Penguin.

Feyerabend, P. (1993). *Against Method*. Verso.

Furuhata, Y. 2019. “Of Dragons and Geoengineering: Rethinking Elemental Media.” *Media+Environment* 1 (1).

Gabrys, J., & Yusoff, K. (2012). Arts, sciences and climate change: practices and politics at the threshold. *Science as culture*, *21*(1), 1-24.

Gaskill, N., & Nocek, A. J. (Eds.). (2014). *The lure of whitehead*. U of Minnesota Press.

Gasset, J.O. y. (1961). *The modern theme*. Harper & Row.

Geertz, C. (1973). Thick Description: Towards an Interpretative Theory of Culture. *The interpretation of cultures*.

Gewin, V. (2021). How to shape a productive scientist–artist collaboration. *Nature.* https://www.nature.com/articles/d41586-021-00397-1 (Accessed February 30, 2021)

Gómez-Barris, M. (2017). *The extractive zone: social ecologies and decolonial perspectives*. Duke University Press.

Gomez-Luque, M. & Ghazal, J. Eds. (2018). Posthuman. *New Geographies 09.* Harvard University Press.

Griffiths, R. B. (2013). A consistent quantum ontology. *Studies in History and Philosophy of Science Part B: Studies in History and Philosophy of Modern Physics*, *44*(2), 93-114.

Grimshaw, A., & Ravetz, A. (2009). *Observational cinema: Anthropology, film, and the exploration of social life*. Indiana University Press.

Guattari, F. (1989). *The Three Ecologies,* new formations, 8 Summer.

Guattari, F. (1995). *Chaosmosis: an ethico-aesthetic paradigm*. Indiana University Press.

Guattari, F. (2010). The machinic unconscious: Essays in schizoanalysis. Taylor Adkins. Los Angeles: Semiotext (e).

Guattari, F. (2012). *Schizoanalytic cartographies*. A&C Black.

Glissant, É. (1997). *Poetics of Relation*. Wing, B. Trans. Michigan University Press.

Glissant, É., & Gauvin, L. (2010). *L'imaginaire des langues*. Paris: Gallimard.

Greenfiled P. and Watts J. (2020). *Record 212 land and environment activists killed last year*. The Guardian. 29 July. https://www.theguardian.com/environment/2020/jul/29/record-212-land-and-environment-activists-killed-last-year

Hage, G. (2015). *Alter-politics: Critical anthropology and the radical imagination*. Melbourne Univ. Publishing.

Halewood, M. (2008). Introduction to Special Section on A.N. Whitehead. *Theory, Culture & Society*, *25*(4), 1–14.

Hall, G. (2017). The Inhumanist Manifesto. *Media Theory, Manifestos*, Vol. 1 (No.1), pp.168 - 178.

Hall, S (2015). "Exxon Knew About Climate Change Almost 40 Years Ago", *Scientific American.* https://www.scientificamerican.com/article/exxon-knew-about-climate-change-almost-40-years-ago/ (accessed February 2020).

Haraway, D. (1988). "Situated knowledges: The science question in feminism and the privilege of partial perspective". *Feminist studies*, *14*(3), 575-599.

Haraway, D. (1992). *The Promises of Monsters: A Regenerative Politics for Inappropriate Others*, in L. Grossberg, C. Nelson and P. Treichler (eds), Cultural Studies. London: Routledge.

Haraway, D. J. (2016). *Staying with the trouble: Making kin in the Chthulucene*. Duke University Press.

Haraway, D. (2015). Anthropocene, capitalocene, plantationocene, chthulucene: Making kin. *Environmental Humanities*, *6*(1), 159-165.

Haraway, D. (2016). Playing String Figures with Companion Species. *Staying with the Trouble: Making Kin in the Cthulucence*, 9-29.

Haraway, D. (2016). Tentacular thinking: Anthropocene, capitalocene, chthulucene. *e-flux Journal*, *75*.

Harding, S. (2008). *Sciences from below: Feminisms, postcolonialities, and modernities*. Duke University Press.

Harding, S. (1991). Whose science. *Whose knowledge*, *1*, 83-106. Open University Press.

Hartley, D. (2015). Against the anthropocene. *Salvage*, *1*, 107-17.

Hartman, S. V. (1997). *Scenes of subjection: Terror, slavery, and self-making in nineteenth-century America*. Oxford University Press on Demand.

Hayles, N. K. (2008). *How we became posthuman: Virtual bodies in cybernetics, literature, and informatics*. University of Chicago Press.

Hayles, N. K. (2012). *How we think: Digital media and contemporary technogenesis*. University of Chicago Press.

Hecht, G. (2018). Interscalar vehicles for an African Anthropocene: On waste, temporality, and violence. *Cultural Anthropology*, *33*(1), 109-141.

Hildyard, D. (2017). *The Second Body.* Fitzcarraldo Editions.

Hodal, A. (2021). *At least 331 human rights defenders were murdered in 2020, report finds*. The Guardian. 11 Feb https://www.theguardian.com/global-development/2021/feb/11/human-rights-defenders-murder-2020-report

Holm, P., Goodsite, M. E., Cloetingh, S., Agnoletti, M., Moldan, B., Lang, D. J., ... & Scholz, R. W. (2013). Collaboration between the natural, social and human sciences in global change research. *Environmental science & policy*, *28*, 25-35.

Holmes, D. R., & Marcus, G. E. (2006). Para-ethnography and the rise of the symbolic analyst. *Frontiers of capital: ethnographic reflections on the new economy*, 33-57.

Hooft, G. T. (1993). Dimensional reduction in quantum gravity. *arXiv preprint gr-qc/9310026*.

Hörl, E. (2017). Introduction to general ecology, *General Ecology: The New Ecological Paradigm*, 1. Bloomsbury.

Hörl, E., & Burton, J. E. (Eds.). (2017). *General Ecology: The New Ecological Paradigm*. Bloomsbury Publishing.

Hörl, E., & Plas, G. (2012). The New Ecological Paradigm. *Multitudes*, (4), 74-85.

Hörl, E. (2013). A Thousand Ecologies. *The Whole Earth. California and the Disappearance of the Outside* (Berlin: Sternberg, 2013), 128-9.

Hui, Y. (2017). On cosmotechnics: For a renewed relation between technology and nature in the anthropocene. *Techné: Research in Philosophy and Technology*, *21*(2/3), 319-341.

Jemisin, N.K. 2017. *The Stone Sky.* Orbit.

Johnson, E., Morehouse, H., Dalby, S., Lehman, J., Nelson, S., Rowan, R., ... & Yusoff, K. (2014). After the Anthropocene: Politics and geographic inquiry for a new epoch. *Progress in Human Geography*, *38*(3), 439-456.

Johnson, E. R. and Kindervater, G. and Todd, Z. and Yusof, K. and Woodward, K. and Povinelli, E. A. (2019) 'Geontographies : on Elizabeth Povinelli's Geontologies : a requiem for late liberalism.', Environment and planning C : politics and space., 37 (8). pp. 1319-1342.

Johnson G.T. & Lubin, A. (Eds). *Futures of Black Radicalism.* Verso.

Jung, C. G. (1983). *The Philosophical Tree, Alchemical Studies* (Collected Works, vol. 13). Abingdon, England: Routledge.

Jung, C. G., & Pauli, W. (1957). The Interpretation of Nature and Psyche.

Kaiser, B. M., & Thiele, K. (2014). Diffraction: Onto-epistemology, quantum physics and the critical humanities.

Kawagley, A. O., Norris-Tull, D., & Norris-Tull, R. A. (1998). The indigenous worldview of Yupiaq culture: Its scientific nature and relevance to the practice and teaching of science. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *35*(2), 133-144.

Kirby, V. (2011). *Quantum anthropologies: Life at large*. Duke University Press.

Kirby, V. (Ed.). (2017). *What if Culture was Nature all along?*. Edinburgh University Press.

Klein, J. *What is artistic research?* http://www.jar-online.net/what-is-artistic-research/ (accessed October, 2017)

Kofman, A. (2018) "Bruno Latour, the Post-Truth Philosopher, Mounts a Defense of Science". The New York Times Magazine. https://www.newyorktimes.com/2018/10/25/magazine/bruno-latour-post-truth-philosopher-science.html (last accessed Apr. 12. 2019).

Kohn, E. (2013). *How forests think: Toward an anthropology beyond the human*. University of California Press.

Kohn, E. (2007). How dogs dream: Amazonian natures and the politics of transspecies engagement. *American ethnologist*, *34*(1), 3-24.

Kwade, A. (2018). *Interview with Alicja Kwade: Time, Space, and Gravity.* https://www.youtube.com/watch?v=jCr5rV2Mbno (accessed Feb. 20, 2021)

Land, N. (2011). Fanged Noumena: Collected writings 1987–2007 (R. Mackay & R. Brassier, Eds.).

Laruelle, F., & Mackay, R. (2012). *From decision to heresy: Experiments in non-standard thought*. Urbanomic.

Laruelle, F. (2013). *Principles of Non-philosophy*. A&C Black.

Latour, B., & Weibel, P. (2020). *Critical Zones: The Science and Politics of Landing on Earth*. ZKM Centre for Art and Media.

Latour, B. & Woolgar, S. (1986) *Laboratory Life: The construction of scientific facts.* Princeton University Press.

Latour, B. (1983). "Give me a Laboratory and I will Raise the World", in *Science Observed: Perspectives on the Social Study of Science.* Knorr-Cetina, K & Mulkay, M. Eds. Sage Publishing.

Latour, B. (2008). What is the style of matters of concern. *Two Lectures in Empirical Philosophy_. Assen, the Netherlands: Koninklijke Van Gorcum*.

Latour, B. (2018). *Down to Earth: Politics in the new climatic regime*. John Wiley & Sons.

Laurikainen, K. V. (2012). *Beyond the atom: the philosophical thought of Wolfgang Pauli*. Springer Science & Business Media.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press.

Leitgeb, N. (2017). Ausstellungen:"Herwig Turk: Landschaft= Labor". *Springerin*, (2), 63.

Leslie, E. (2006). *Synthetic worlds: nature, art and the chemical industry*. Reaktion Books.

Lewis, P. J. (2016). *Quantum ontology: a guide to the metaphysics of quantum mechanics*. Oxford University Press.

Littlebear, L. (2015) *Indigenous Knowledge and Western Science.* https://www.youtube.com/watch?v=gJSJ28eEUjI (Accessed March 2020)

Mackay, R. (2012). Introduction: Laruelle Undivided. *François Laruelle, From Decision to Heresy: Experiments in Non-Standard Thought, edited by Robin Mackay*, 1-32.

Manning, E. (2016). *The Minor Gesture*. Duke University Press

Manning, E. & Massumi, B. (2014) *Thought in the Act: Passages in the Ecology of Experience.* Minesotta University Press.

Maoilearca, J. Ó. (2015). *All thoughts are equal: Laruelle and nonhuman philosophy*. University of Minnesota Press.

Marcus, G. E., & Saka, E. (2006). Assemblage. *Theory, Culture & Society*, *23*(2–3), 101–106. https://doi.org/10.1177/0263276406062573

Marder, M. (2019). On the Vegetal Verge (With Saint Hildegard). *Comparative and Continental Philosophy*, *11*(2), 137-146.

Marder, M. (2018). Saint Hildegard's Vegetal Psycho-Physio-Theology. *Religions*, *9*(11), 353.

Marder, M. (2020). *Resonances*. (forthcoming).

Marker, M. (2018). There is no place of nature; there is only the nature of place: Animate landscapes as methodology for inquiry in the Coast Salish territory. *International Journal of Qualitative Studies in Education*, *31*(6), 453-464.

Massumi, B. (2002). *Parables for the virtual: Movement, affect, sensation*. Duke University Press.

Mbembe, A., Bangstad, S. & Nilsen, T. (2019). Thoughts on the planetary: An interview with Achille Mbembe. *New Frame,* 5.

McCarthy, P. (2004) The Genesis of "Star Maker". *Science Fiction Studies.* Vol. 31, No. 1 (Mar., 2004), pp. 25-42.

Meredith, M. (2015) *All Problems Can Be Illuminated; Not All Problems Can Be Solved*. http://bb9.berlinbiennale.de/all-problems-can-be-illuminated-not-all-problems-can-be-solved/ (accessed February 15 2020).

Meillassoux, Q. (2010). *After finitude: An essay on the necessity of contingency*. Bloomsbury Publishing.

Meillassoux, Q. (2012). *The Number and the Siren: A Decipherment of Mallarmé's Coup de dés.* Sequence Press.

Meillassoux, Q., & Edlebi, A. (2015). *Science fiction and extro-science fiction*. University of Minnesota Press.

Meyer, M. A. (2013). Holographic epistemology: Native common sense. *China Media Research*, *9*(2), 94-101.

Middleton, P. (2015). *Physics Envy: American Poetry and Science in the Cold War and After*. University of Chicago Press.

Mignolo, W., & Vázquez, R. (2013). Decolonial aesthesis: Colonial wounds/decolonial healings. *Social text*, *15*, 2013.

Mignolo, W. D., & Walsh, C. E. (2018). *On decoloniality: Concepts, analytics, praxis*. Duke University Press.

Milovanovic, D. (2013). Postmodernism and thinking quantum holographically. *Critical Criminology*, *21*(3), 341-357.

Mosko, M. (2010). Fractal holography in Trobriand agency and culture. *Experiments in Holism: Theory and Practice in Contemporary Anthropology. Malden, MA: Wiley-Blackwell*, 150-173.

Moten, F & Tsang, W. (2016) "Who Touched Me?" *If I Can't Dance, I Don't Want To Be Part Of Your Revolution* [Exhibition], Amsterdam.

Moten, F. (2018). "Notes on Passage" in *Stolen Life* (Vol. 2). Duke University Press.

Neimanis, Astrida. "Bodies of water, human rights and the hydrocommons." *TOPIA: Canadian Journal of Cultural Studies* 21 (2009): 161-182.

Nelson, M. (2002). *Bluets.* Wave Books.

Nail, T. (2017). What is an Assemblage?. *SubStance*, *46*(1), 21-37.

Nitzan, J., & Bichler, S. (2009). *Capital as power: A study of order and creorder*. Routledge.

Oliveros, P. (2005). *Deep listening: A composer's sound practice*. IUniverse.

Olufemi, L. (2021). *Experiments in Imagining Otherwise.* Hajar Press.

Orlow, U. & Sheikh, S. (Eds) (2019). *Theatrum Botanicum.* Sternberg Press.

Paglen, T. (2012). *The Last Pictures*. University of California Press.

Pauli, W. (1994). The influence of archetypal ideas on the scientific theories of Kepler. In *Writings on physics and philosophy* (pp. 219-279). Springer, Berlin, Heidelberg.

Parikka, J. (2015). *A geology of media* (Vol. 46). Minneapolis: University of Minnesota Press.

Parikka, J. (2014). *The anthrobscene*. University of Minnesota Press.

Parikka, J. (2012). New materialism as media theory: Medianatures and dirty matter. *Communication and Critical/Cultural Studies*, *9*(1), 95-100.

Parisi, L. (2017). Computational logic and ecological rationality. *General Ecology: The New Ecological Paradigm*, 75.

Parks, L., & Starosielski, N. (Eds.). (2015). *Signal traffic: Critical studies of media infrastructures*. University of Illinois Press.

Peters, J. D. (2003). Space, time, and communication theory. *Canadian Journal of Communication*, *28*(4).

Pickering, A. (1996). *The mangle of practice: Time, agency, and science*. University of Chicago Press.

Pingree, D. (1980). Some of the Sources of the Ghāyat al-hakīm. *Journal of the Warburg and Courtauld Institutes*, *43*(1), 1-15.

Polska, A (Ed) (2018). *The Demons Brain.* Walther Konig Buchhandlung.

Povinelli, E. A. (2016). *Geontologies: A requiem to late liberalism*. Duke University Press.

Price, L. (1955). Dialogues of Alfred North Whitehead.

Prescod-Weinstein, C. (2017a). *The Self-Construction of Black Women Physicists.* Medium.

Prescod-Weinstein, C. (2017b). *Black Women Physicists In the Wake.* Medium.

Prescod-Weinstein, C. (2021). *The Disordered Cosmos: A Journey in to Dark Matter, Spacetime, and Dreams Deferred.* Bold Type Books.

Ray, M. K. (2015). *Daughters of Alchemy*. Harvard University Press.

Rancière, J. (2015). *Dissensus: On politics and aesthetics*. Bloomsbury Publishing.

Rekret, P. (2018). The Head, the Hand, and Matter: New Materialism and the Politics of Knowledge. *Theory, Culture & Society*, *35*(7-8), 49-72.

Rheinberger, H. J. (1997). *Toward a History of Epistemic Things: Synthesizing proteins in the test tube*. Stanford University Press.

Reinberger, H. J. (1994). Experimental systems: Historiality, narration, and deconstruction. *Science in Context*, *7*(1), 65-81.

Rheinberger, H. J. (1995). From experimental systems to cultures of experimentation. *Concepts, theories, and rationality in the biological sciences*, 1-4.

Rheinberger, H. J. (2013). Forming and Being Informed. *Experimental Systems: Future Knowledge in Artistic Research*, 198.

Rheinberger, H. J. (2010). The Art of Exploring the Unknown: Views on Contemporary Research in the Life Sciences. *Science as Cultural Practice: Vol. I: Cultures and Politics of Research from*

the Early Modern Period to the Age of Extremes. Epple, M. & Zittel, C. Eds. Akademie Verlag, Berlin. 141 – 152.

Rheinberger, H. J. (2014) Experimental Systems. The Virtual Laboratory. http://vlp.mpiwg-berlin.mpg.de/references?id=enc19&page=p0002 (accessed March 15, 2018)

Rheinberger, H. J. (2010). *An epistemology of the concrete: Twentieth-century histories of life*. Duke University Press.

Rheinberger, H-J. (2013) "Forming and being informed: Hans-Jörg Rheinberger in conversation with Michael Schwab." *Experimental systems: future knowledge in artistic research*. Leuven University Press. 198-219.

Rosiek, J. L., Snyder, J., & Pratt, S. L. (2020). The new materialisms and Indigenous theories of non-human agency: Making the case for respectful anti-colonial engagement. *Qualitative Inquiry*, *26*(3-4), 331-346.

Rüger, A. (1989). Complementarity meets general relativity: A study in ontological commitments and theory unification. *Synthese*, *79*(3), 559-580.

Ronell, A. (2003). Proving grounds: on Nietzsche and the test drive. *MLN*, *118*(3), 653-669.

Ronell, A. (2005). *The Test Drive*. University of Illinois Press.

Samuel, E. (2002). The Universe is not Turqouise, it's Beige! *New Scientist* *https://www.newscientist.com/article/dn2013-the-universe-is-not-turquoise-its-beige/* (Accessed May 12, 2021).

Santillan, O. (2017). *5 Questions with Oscar Santillan*. Elephant Magazine. https://elephant.art/5-questions-oscar-santillan/ (Accessed May 15, 2021).

Saraceno, T. *Tomás Saraceno Interview: The Arts of Noticing.* Louisiana Channel. https://www.youtube.com/watch?v=0p1JSnKa1Ao (Accessed Dec 1, 2020).

Schwab, M. (Ed.). (2013). *Experimental systems: future knowledge in artistic research*. Leuven University Press.

Schwab, M. (2015) Experiment! Towards an artistic epistemology, Journal of Visual Art Practice, 14:2, 120-131

Schwab, M. (2014). Artistic Research and Experimental Systems. *Artistic Experimentation in Music: An Anthology*, 111.

Schmidt, J. J., Brown, P. G., & Orr, C. J. (2016). Ethics in the Anthropocene: A research agenda. *The Anthropocene Review*, *3*(3), 188-200.

Schlegel, M. von (2014). *Ickles, etc.* MIT Press.

Sharpe, C. (2016). *In the wake: On blackness and being*. Duke University Press.

Shaw, C. & Turpin, E. Eds. (2018) *The Work of Wind: Land.* K Verlag.

Shklovsky, V. (2015). Art, as Device. *Poetics Today*, *36*(3), 151-174.

Shklovsky, V. (2011). *Bowstring: On the Dissimilarity of the Similar*. Dalkey Archive Press.

Shklovsky, V. (2007). Art as technique [1917]. *The Critical Tradition: Classic Texts and Contemporary Trends, New York*, *3*, 774-784.

Sideris, L. H. (2013). Science as sacred myth? Ecospirituality in the Anthropocene age. In *Linking Ecology and Ethics for a Changing World* (pp. 147-162). Springer, Dordrecht.

Sideris, L. H. (2017). *Consecrating Science: Wonder, Knowledge, and the Natural World*. University of California Press.

Simonetti, C. (2020). Dwelling in the Anthropocene. In *Global Changes* (pp. 141-151). Springer, Cham.

Simonetti, C. (2019). The Petrified Anthropocene. *Theory, Culture & Society*, *36*(7-8), 45-66.

Simpson, L. (Ed.). (2008). *Lighting the eighth fire: The liberation, resurgence, and protection of Indigenous nations*. Arp Books.

Smith, L. T. (2013). *Decolonizing methodologies: Research and indigenous peoples*. Zed Books Ltd..

Stengers, I. (2018). *Another Science is Possible.* Muecke, S. Trans. Polity Books.

Stengers, I. (2005). Introductory notes on an ecology of practices. *Cultural Studies Review*, *11*(1), 183.

Stengers, I. (2012). *Reclaiming Animism.* e-flux Journal #36. https://www.e-flux.com/journal/36/61245/reclaiming-animism/ (accessed February 2021)

Stiegler, B. (1998). *Technics and time: Disorientation* (Vol. 2). Stanford University Press.

Stiegler, B. (1998). *Technics and time: The fault of Epimetheus* (Vol. 1). Stanford University Press.

Stiegler, B., & Ross, D. (2017). What Is Called Caring?: Beyond the Anthropocene. *Techné: Research in Philosophy and Technology*.

Strathern, M. (1992). *Reproducing the future: essays on anthropology, kinship and the new reproductive technologies*. Manchester University Press.
Talbot, M, (1991). *The Holographic Universe.* Harper Collins.

Tarkovsky, A., & Hunter-Blair, K. (1987). *Sculpting in time: reflections on the cinema*. University of Texas Press.

Tarkovsky, A. (1986) *Time Within Time: The Diaries 1972-1986.*

Taubes, G. (1986) *Nobel Dreams*. Random House, Inc. New York, USA.

Thalos, M. (2013). *Without hierarchy: the scale freedom of the universe*. Oxford University Press.

The Office of Experiments (2010). Principles and Articles. http://www.o-o-e.org/principles.html (accessed February 12, 2018)

Thiele, K. (2014). Ethos of diffraction: New paradigms for a (post) humanist ethics. *Parallax*, *20*(3), 202-216.

Thomson, J., & Engelmann, S. (2017). Intra-acting with the IceCube Neutrino Observatory; or, how the technosphere may come to matter. *The Anthropocene Review*, *4*(2), 81-91.

Thrift, N. (2008). *Non-representational theory: Space, politics, affect*. Routledge.

Triscott, N. 2017. *Art and Intervention in the Stewardship of the Planetary Commons: Towards a Curatorial Model of Co-inquiry.* PhD thesis University of Westminster Centre for Research and Education in Arts and Media

Triscott, N. (2017). Curating contemporary art in the framework of the planetary commons. *The Polar Journal*, *7*(2), 374-390.

Triscott, N., & Steadman, A. (2016). Notes from the Field: Commoning Practices in Art and Science.

Triscott, N. (2018). The Live Creature & Ethereal Things. *The Live Creature and Ethereal Things*, 14.

Tsing, A. L., Bubandt, N., Gan, E., & Swanson, H. A. (2017). *Arts of Living on a Damaged Planet: Ghosts and Monsters of the Anthropocene*. University of Minnesota Press.

Tuck, E., & McKenzie, M. (2014a). *Place in research: Theory, methodology, and methods*. Routledge.

Tuhiwai, S. L. (1999). Decolonizing methodologies: Research and indigenous peoples. Zed.

Turpin, E. & Sedlar, F. *Conspiracy of the Anthros*. https://www.youtube.com/watch?v=baMWCx6kwoo&feature=youtu.be (accessed Nov.12, 2017)

Tzara, T. (1922). Lecture on Dada. Motherwell, R. (trans.). In Chipp, H. B., & Selz, P. (1968). *Theories of modern art: A source book by artists and critics*. Univ of California Press.

Van Dooren, T., Kirksey, E., & Münster, U. (2016). Multispecies studies: Cultivating arts of attentiveness. *Environmental Humanities*, *8*(1), 1-23.

Van Wyck, P. (2010) *The Highway of the Atom*. McGill-Queens University Press.

Vergés, F. (2017). *Racial Capitalocene* in "Futures of Black Radicalism", Johnson G.T. & Lubin, A. Eds. Verso Books.

Wagner, R. (1991). The Fractal Person. *Big Men and Great Men: Personifications of Power in Melanesia*, eds. M. Godelier and M. Strathern. Cambridge University Press.

Wagner, R. (2001) *An anthropology of the subject: Holographic worldview in New Guinea and its meaning and significance for the world of anthropology*. Univ of California Press.

Wagner, R. (2017). *The logic of invention*. Hau Books.

Wang, J. (2018). *Carceral capitalism* (Vol. 21). MIT Press.

Wark, M. (2019) *Elizabeth Povinelli: When the Rocks Turn Their Back On Us.* Verso Books. https://versobooks.com/blogs/4236-elizabeth-povinelli-when-the-rocks-turn-their-backs-on-us (accessed March 16, 2019)

Wark, M. (2019) *Kathryn Yusoff: A Billion Black Anthropocenes.* Verso Books. https://www.versobooks.com/blogs/4225-a-billion-black-anthropocenes (accessed March 16, 2019)

Watts, V. (2013). Indigenous place-thought and agency amongst humans and non humans (First Woman and Sky Woman go on a European world tour!). *Decolonization: Indigeneity, Education & Society*, *2*(1).

Watts, J. 2018. *Nine activists defending the Earth from violent assault.* The Guardian. July 21. https://www.theguardian.com/environment/2018/jul/21/defending-earth-violence-murder-activists-land-corruption

Weheliye, A. G. (2014). *Habeas viscus: Racializing assemblages, biopolitics, and black feminist theories of the human*. Duke University Press.

Where are We Going, Walt Whitman? https://www.youtube.com/watch?v=rpbkA8HwTJs (accessed 10.10.2017)

Whitehead, A. N, and Douchement, J. (1957) *The concept of nature*. Vol. 5. Ann Arbor: University of Michigan Press.

Whitehead, A. N. (1954) *Science and the Modern World.* The Macmilan Company.

White, N. (2017). The potential of destruction in art and science. *Interdisciplinary Science Reviews*, *42*(1-2), 214-224.

Wilk, E. (2018) *Is Ornamenting Solar Panels a Crime?* E-flux:positions. http://www.e-flux.com/architecture/positions/191258/is-ornamenting-solar-panels-a-crime/ (accessed April 17, 2018)

Windchief, S. (2020). Holographic Epistemology (Indigenous Common Sense): A Nakòna Example. *Indigenous Knowledge Systems and Research Methodologies: Local Solutions and Global Opportunities*, 50.

Wynter, S. (2015). "Unparalleled catastrophe for our species? Or, to give humanness a different future: Conversations" In *Sylvia Wynter: On being human as praxis*, edited by Katherine McKittrick. 9-89. Duke University Press.

Yusoff, K. (2013a). Insensible worlds: postrelational ethics, indeterminacy and the (k)nots of relating. *Environment and Planning D: Society and Space*, *31*(2), 208-226.

Yusoff, K., & Gabrys, J. (2011). Climate change and the imagination. *Wiley Interdisciplinary Reviews: Climate Change*, *2*(4), 516-534.

Yusoff, K. (2013b). Geologic life: Prehistory, climate, futures in the Anthropocene. *Environment and Planning D: Society and Space*, *31*(5), 779-795.

Yusoff, K. (2019) *A Billion Black Anthropocenes or None*. University of Minnesota Press.

Yusoff, K. (2019b) *White Utopia/Black Inferno: Life on a Geologic Spike.* E-flux 97. https://www.e-flux.com/journal/97/252226/white-utopia-black-inferno-life-on-a-geologic-spike/ (accessed November 2019)

Zalasiewicz, J., Waters, C. N., Summerhayes, C. P., Wolfe, A. P., Barnosky, A. D., Cearreta, A., ... & Haff, P. (2017). The Working Group on the Anthropocene: Summary of evidence and interim recommendations. *Anthropocene*, *19*, 55-60.

Accompanying Material

Videos (Links to videos also available through the text at the heading of each chapter):

A Borderline Conception Lying at the Extreme Edge of the World of Appearances
(10 minutes, HD, Color, Stereo) 2017-2019

https://vimeo.com/401657551

P/W: Appearances.

***Viriditas* (In the Future Perfect)**
(21 minutes, HD, Color, Stereo) 2019-2020

https://vimeo.com/372626442

P/W: viridita5

n-Land: the holographic (principle)
(17 minutes, HD and 4K versions, 5.1 Surround) 2021

https://vimeo.com/504477365
Password: holograph

Matter:

(Due to COVID restrictions, a hard copy of this thesis is postponed until an unspecified later date making the inclusion of these materials ambiguous)

1. A norite (highly compacted granite) stone from Sudbury Basin Impact Structure where SNOlab and Vale's Creighton mine is located; the territory of the Robinson-Huron Treaty, Ontario, Canada. (Project link: *n-Land*)

2. An unspecified calcite stone with burgundy crystal inclusion from Lake Baikal, Siberia, Russia. (Project Link: *A Borderline Conception…*)

Viriditas (In the Future Perfect)
Transcript

[Bell Ringing]

Good evening initiates,

We are gathered here this evening, conjuring an *epiphenomenal time*-space, where borders or limits no longer reign.

The twelve keys will as ever guide us in our terrestrial work to close the window of annihilation left open since the first atomic bomb tests;
and in the wake of Mayak, Chernobyl, Sellafield, Fukushima, and others.
And to do the work to close that window,
that window that has ripped protracted holes in times and in time and
in earth, and in time, and futures, earths, and others.

Regarding resonance and frequency fluctuations, please do not wary.
And in regard to associated tremors, harmonics, and instability phenomena in the plasma containment, surely the *Anima Mundi* will determinedly release us from these multiple magnetic perils in due course.

And in regard to the explicit reconfiguration of the world,
greenly, its energy demands and productions, its economics, exploitations, extractions, and devices of rule,
so outlandish,
it is imperative to dis/close that ruinous calamity,
to reconsider '*the authentic implications of the principles governing the behaviours of stars'*.

And so, in regard to renewing our concepts of fuels, energies and logics,
and towards the rare, *rare* earth minerals necessary for the terrestrial fusion-star to shine,
for a 'clean' *plasma* energy constellation to succeed, surpassing and supplanting necro-fuels, this is our investigation.

///

We know the deep time nuclear fission technologies continue to fail and corrupt her most precious and precarious body,
and it is for this reason we call forth
the *Prima Materia*,
so that we may enter the zone and plane of *Viriditas*, literally
green-ness.

We must ask those gathered here now to remember, to do your utmost to recall

What it is to build a star

For we naïve and clever beings to generate a local solar potential here, on and with the earth
And to harness it for telluric exuberance,
the dawning of a solar light,
the yellowing of the lunar conscious,
to reach towards what we have for centuries referred to as *Xanthosis.*

///

Whereas in the alchemical text of Marsilio Ficino four suns are described:
Nigredo (Black), Albedo (White), Rubedo (Red), Citrinitas (Yellow) -
Corresponding to the Quaternity of early alchemical color stages.

Of the *Black Sun* Ficino writes:
"The body must be dissolved in the subtlest middle air,
The body is also dissolved by its own heat and humidity; where the soul,
the middle nature holds the principality in the colour of blackness all in the glass"
which blackness of Nature the ancient Philosophers called the *crows* head, or the black sun.

If you will be kind enough to recall with me now the lines from the Martinique poet Aimé Césaire:

"If we plumb the depths, then what we will find is fundamentally black… [it is] a process of disalienation…. I felt that beneath the social being would be found a profound being, over whom all sorts of ancestral layers and alluviums had been deposited".[49]

/// Flute///

And so the three-legged crow [Yangwu] again returns to us -
alas, emerged from
the pelican,
the peacock,
the swan,
all through to the phoenix.

The ashes of the phoenix's self-immolation is said to in/deed transmutate back into the body of the crow, as the ashes of stars produce all the 10,000 things of our worlds and all of their 70,000 veils.

"Crow roots a problem and inspires a goal." (Magar, M.J.)

[49] Césaire in response to his influence to and from surrealism: 'An interview with Aimé Césaire by Rene Depestre', in *Discourse on Colonialism*, Joan Pinkham, Trans. Monthly Review Press, 2000. p.84.

The birds of alchemy are descriptive of certain stages of the alchemical process...
and life experience, just as the colours, red, white, yellow, black, and green are.

Which birds pass now under our sun, star class G3, and for how much longer?

For Paracelsus, of course, the alchemical phoenix is synonymous with the word 'iliaster,' which he invented from roots *hyle* (matter) and *astrum* (star) to describe *Prima Materia* (prime matter), the *formless* essence that defines *all* matter.

But *iliaster* is a term which "*consists of body and soul*", and we should keep this in mind when curiosity strikes about the relevance of our divisory quantitative 'modern' age in relation to an alchemical metaphysics still rooted in Earth, element and material.

For as we surely are all aware
our western pre-moderns had yet to distinguish,
to bifurcate the mind from the world,
the body from nature.
Indeed the history of modernity is also a series of excisions,
dissections, separations, limits -
of things once held together in our ways
now seemingly long lost

///

Before a Trinity, there was the holistic self-manifesting Quaternity.
4, sets of 4; the seasons, the elements, the 4 zodiacal arrangements;
the cardinal points, the fact that all other numbers can be generated from it,
from the number 4.
And yet still we must surpass historical numeracy, into the new *Xanthosis*.
Perhaps the element or colour of that fifth elemental phase, that of the plasmatic,
the plasma that the stars confide….

Protium, Deuterium, Tritium these are the triad isotopes of hydrogen, the primal elements from the apparent 'big bang', the fuel of future fusion reactors,
fuel of our solid being, of stars, and nebulae,
plasmaticly the aetheric energy that produces all other quantifiable matters through iterative sequences of supernovae,
star cycle after star cycle,
rotations and revolutions across aeons and aeons
in aeons of aeons.

The telluric transmutation of a star harnessed and called forth here on earth - 'prima materia' - contained in a magnetic vessel burning 150 million degrees centigrade is a possible green

technology that has, every year, for the last 80 years, and likely for the next 80 years - remained technically and practically *thirty years* away - Always out of our reach. From the 1940's to the 2nd decade of the 21st century it remains as ever, 30 years away, out of our grasp: in the future perfect.

– but is our approach not still deeper?

The playing of the revolutions of Ptolemy and Copernicus are doubly troubled, quadrupled.

What would geocentric or heliocentric mean in these obsessive energetics of a sustained terrestrial stars ignitions?

What about that which speaks, but cannot be spoken?
The ineffable at the heart of all things…

These local, terrestrial stars, are pulsing, bleeding, blipping, and propose a promise of renewal for a planet deeply troubled by its inhumane practices of consuming the dead, metabolising the living ancestry of the planet, while dissecting and leaving it for nought.

///

Viriditas is a word meaning vitality, fecundity, lushness, verdure, or growth.
A greenness particularly associated with abbess *Hildegard von Bingen,* also known as the 'Sibyl of the Rhine', touched as she was by the sun's rays. The 12th century polymath who used the term *Viriditas* to refer to or symbolize spiritual and physical health, often as a reflection of the divine word or as an aspect of the divine nature. And yet in our time Health escapes us and Nature is depleted…

If you will recall how time has multiple dimensions, alleyways and avenues, directions and potentials, you will awake again into the knowledge of an *epiphenomenal time* where everything old is new again,
all time all of the time,
all around us . . . [50]

In this pale light Is the 12th c. Viriditas of von Bingen, not the contemporary New Deal in Green? Is there not somewhere hidden under these intentions the image of an awakening within our fierce present, zigzagged as it is, crosshatched with apocalypses dating back at least half a millennia when the searing White Death of colonialism poured itself into the worlds of Africa and the Americas, displacing and enslaving millions?

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[50] See Michellle Wright's *ICI Berlin* lecture "On Epiphenomenal Temporality: Black German Identities and Quantum Physics in the African Diaspora"

And I recall now 'the Orbis spike' (Lewis & Maslin) as merely one of the ways that Earth holds and reveals the 'White Geological' (Yusoff, K.) abhorrence's.

///

For nearly half a century withholding knowledge of what fossil fuels do to the environment, to the atmospheres, to our geosocial bodies, and without any repercussions whatsoever, and in fact still wielding power and privilege,
still desacralizing our world, our connections, simply interested in turning any and everything, at any cost into… (profit, profit, profit)
gold for their coffers; power and control for their ego's - all at the expense of habitability, *difference without separability* (Da Silva, D.F.), & relation with/in the 'Otherwise'.

Those wily harbinger demons have exploited, ransacked, plundered, maniacally – in the name of discovery, energy, and colony…
And now they lie in waiting, their heads again rearing, ready for the planetary situation to get still worse, so dire, so helpless, that we - again - can only resort to *their* geoengineering strengths,
helplessly in the collapse we must resort to *their* knowledges, *their* technological gifts,
their forms of 'care', *their* accounts of what is meaningful.

///

Alkahest was believed to be the essential agent of transformation in alchemy. It is the name given by the ancients to *mercury*, or Azoth, the animating spirit hidden in all matter that makes transmutation possible.
And here we remember the caduceus,
Or the winged foot of the messenger Hermes…

This *Alkhahest* is reminiscent to what the Sufi's and other mystical traditions refer to as *the Absolute,* what Taoist refer to as the Tao, the path or the way.

Tao called Tao is not Tao [51]

What mercurial changes can transmute our earthly spirit to truly reach *Viriditas?*
Can a constellation of telluric stars suppress and capture those most heinous and venomous of the necrophilic demons? [Bell Ringing]

Called Jua, Sol, Soleil, Ilanga, Sonne, Ra, Matahari, Shams, Taeyang, Solis.
('But *this* is no ordinary sun')

[51] 1st line of the first section of the first of part of the *Tao Te Ching*

How can what we've lost in the divisory modern project be renewed – and to this question we are gathered …
Not just here, as you know, not merely in this time, this space or this light - however dim - but across all times, gathering the spirits and elements and forces back, forwards – ancestrally, into relations, expanding, re-enforcing.

These 'pataphysical megaprojects? Imaginary solutions (?)
With contexts and Histories reaching back even before the alchemical tradition to at least the 11th c. *Picatrix* of Hayyam al Ghatam when something like a scientific method was first written - scribed in that ancient book of talismanic magic . . .

But now, as we prepare to return, (nigredo) could it be we've just been dreaming the 16th c. illuminated *Splendor Solis* of Salomon Trismosin? The Splendor, you will recall (albedo) consists of a symbolic process showing the classical alchemical stages of death and rebirth and incorporates a series of seven flasks, (citrinitas) – each associated with one of the planets.

Within the flasks a process is shown involving the transformation of bird and animal symbols into individuated selves. (rubedo) But Which is the color, flask, animal or planet of *reintegration*?
That obscured reality of togetherness with all things…

Can it be 'Viriditas' to reveal the relation that will elicit care and sensitivity?

When will it bloom in conjunction and syzygy?

These times breathe the living ancestry of Europe, rooted in each and every contemporary detail, regardless of desires to sequester or banish them.

Come now, come back to the fire…

What is this exception? This anomaly?
What are all these magic formulas and technologies that promise and profess to have capacities to dissolve the fuels of fossils that smother all lives, always 30 years away . . . ?

These are some lasting questions from within 'epi-phenomenal time'
and a veridical dream,

I thank you for your attention.
[Bell Ringing]

Viriditas: In the Future Perfect
77 Images in Order of Appearance

0. The Alchemist Symbol (of) The 'Philosophers Stone' (17th Century)

1. MAST.gif. 'Plasma in the Tokamak' CCFE. Used with permission.

2.'The Twelve Keys of Basil Valentine' (orig. pub: 1599) Basil Valentine [engraved by Matthaeus Merian (1593–1650), and published in the collection *Musaeum hermeticum*, Francofurti : Apud Hermannum à Sande, 1678] These files comes from Wellcome Images, a website operated by Wellcome Trust, a global charitable foundation based in the United Kingdom. The images have been animated and color graded.

3. *Trinity Test Fireball 16ms*. (1945) PD.

4. *Runit Dome* (or *Cactus Dome*), Runit Island, Enewetak Atoll. Aerial view. US Defense Special Weapons Agency. PD.

5. MAST Gif 2. CCFE. Used with permission.

5. *Art as the Mirror of All Nature*. Matthaus Merian the Elder (Swiss, 1593–1650). Engraving in Robert Fludd, *Utriusque cosmi maioris scilicet et minoris . . . historia* (Oppenheim, 1617–1621. Wellcome Library, London. Copyrighted work available under Creative Commons Attribution only license CC BY 4.0. Animated scrolling.

6. Ulisse Aldrovandi Historia Monstrorum (1642) called *Animal Africanum Deforme*. PD

7. Engraving from work of Giovanni Battista Diana Paleologo (1656-1744) [AM]

8. Malachias Geiger, Microcosmus hypochondriachus, Munich, 1651.[AM]

9. *Strip-Mining Sulfur at Pozzuoli.* Anton Eisenhoit (German, 1553/4–1603)
Engraving in Michele Mercati, *Metallotheca Vaticana* (Rome, 1717). PD.

10. Group of JET Gifs. CCFE. Used with permission.

11. From *Liber Divonorum Operum* Hildegard of Bingen. (13th C.): Part I, Vision 4: Cosmos, Body, and Soul: The Word Made Flesh.

12. Prima Materia, Emblem 36. 1617. Atalanta Fugiens, Michael Maier. Engraving by Matthias Merian. PD

13. Mast Image. CCFE. Used with permission.

14. 18th century engraving based on work of Basil Valentine.

15. Engraving from Goossen van Vreeswyk, 1672. PD

16. Engraving from Karl von Eckhartshausen, Zahlenlehre der Natur, Leipzig, 1794. [AM]

17. Brunnen der Weisheit - 1757 [AM]

18. From JJ Hollandus, *Chymische Scrifften*, Vienna 1773. [AM]

19. Excerpt from the book D. Stolcius von Stolcenberg, 1624, Viridarium chymicum, Frankfurt am Main. It shows the 4 elements: from left to right, earth, water, air and fire. PD.

20. The black sun as pictured in the Putrifaction emblem of *Philosophia Reformata* (Johann Daniel Mylius). PD

21. Diana Ephesina aus dem Actorum Chemicorum Holmensium , S. : Joachim von Sandrart I (1606-1688) The Ephesian Artemis from the Teutsche Academie

22. Engraving depicting Maria Prophetissima from Michael Maier's book *Symbola Aurea Mensae Duodecim Nationum* (1617). Engraving by Matthias Merian. [AM] On Maria, see: https://en.wikipedia.org/wiki/Mary_the_Jewess

23. Frontispiece from *Microcosmus Vorspiele das neuen Himmels und das neuen Erde,* 1744. [AM]

24. The *Heinrich Khunrath*. Amphitheatrum sapientiae aeternae. [Hamburg: s.n., 1595]. PD

25. Portrait of Aimé Cesaire. Fair Use / Purposes of Illustration.

26. Engraving from Goossen van Vreeswyk, 1672. PD

27. Three legged Crow. YangWu. Woodblock print. PD.

28. Engraving from Goossen van Vreeswyk, 1672. PD

29. Splendor Solis, Salomon Trismosin. PD

30. Unknown Image. 3 Legged Phoenix.

31. *Philosophia Reformata. Johan Daniel Mylius, 1622. [AM]*

32. From *Splendor Solis*, Salomon Trismosin.

33. *Pandora*, Johann Marchand, 1588. PD

34. *The Alchemist who has Achieved Illumination*. Zoroaster Clavis Artis, MS Verginelli-Rota. 1737. PD.

35. Engraving from Goossen van Vreeswyk, 1672. PD

36. From *Scivias* Hildegard von Bingen, 12th C.

37. From Splendor Solis, Trismosin.

38. CCFE MAST Gif3. Used with permission.

39. Nicolas de Loques, Les Rudiments de Philosophie Naturelle, Paris, 1665. [AM]

40. Johan Sternhals, *Ritter-Krieg*, Erfurt, 1595. [AM]

41. Christopher Love Morley, *Collectanea Chymica Leydenisea,* Leiden 1693. {AM}

42. Giovanni Battista Nazari, from *Il metamorfosi metallico et humano...* Brescia, 1564. PD

43. Emblem 21. 1617. Atalanta Fugiens, Michael Maier. Engraving by Matthias Merian. PD

45. (The man in a bottle image in the video) approximately 15th century. Origin unknown.

46. Leonhard Thurneisser from *quinta Essentia*, 1574.

47. MAST gif from CCFE, UK.

48. *four orbs govern this work of fire*. Michael Maier's Atalanta Fugiens emblem 17 by Matthias Merian. PD

49. from Jean de La Fontaine de Valenciennes, *La fontaine des amoureux de science...*, Lyon: Pierre Rigaud, 1618. PD.

50. *The 4 Seasons*. Excerpt from the book D. Stolcius von Stolcenberg, 1624, Viridarium chymicum, Frankfurt am Main. Engravings by Matthias Merian. PD

51. JET plasma image from CCFE.

52. Three Isotopes of Hydrogen PNG. PD

53. ITER section Image.

54. Engraving from von Welling, Frankfurt 1760.PD

55. Images from Cleopatra, 1st-3rd century. PD

56. Jean Brouatt. Traité de L'eau de Vie, 1646. [AM]

57. Engraving from von Welling, Frankfurt 1760.PD

58. Cleopatra *Ouroboros* (1st-3rd C.)

59. 2 CCFE JET Gif. Used with Permission

60. *Perspectives of Anaximanders Universe*. Dirk L. Couprie. GNU Free Documentation Licence

61. *Calculating Celestial Movement*. Peter Hille (German, d. 1574) Engraving in Leonhard Thurneisser zum Thurn, [Der Planeten] Circkel und Lauff (Berlin, 1575). PD

62. Johan Daniel Mylius, Pous Medico Chemicum, 1618

63. Engraving from von Welling, Frankfurt 1760.PD

64. Rosicrucian Cross. Khunrath. 1585. PD

65. Hildegard von Bingen. *empfängt eine göttliche Inspiration und gibt sie an ihren Schreiber weiter*. PD.

66. *Vision of the Angelic Hierarchy*. H. von Bingen. (12th c.) PD

67. Engraving from von Welling, Frankfurt 1760.PD

68. Engraving from von Welling, Frankfurt 1760.PD

69. [Adam Mclean Image]

70.Atalanta Fugiens Engraving by Michael Maier. Emblem 20. 1620. PD

71.*Dutch Slave Ship Arrives In Virginia* is a photograph by Hulton Archive of a work in public domain.

72. *Mapa del Infierno*, obra de Sandro Botticelli. 15th c. PD

73. *The Hermetical Triumph* frontispiece, 1723 by P. Hanet. PD

74.*George Ripleys Wheel*, from 'Thetrum Chemicum Brittainicu', 1652. PD

75. Illumination from *Liber Scivias*, Hildegard of Bingen. PD

76. The Splendor Solis (1532). Salomon Trismosin. PD

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