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Disclosing Mathematics

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Disclosing Mathematics

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Abstract

According to Heidegger, phenomenology is critical of purely metaphysical thinking insofar as the history of Western metaphysics has discounted the significance of *physis*. For Heidegger, Western metaphysics has lost its way by 'forgetting' being, and likewise so has logic. This paper will argue that if mathematics aims to investigate the truth of being, then ontology has been divorced from the investigation of mathematical truth in a similar fashion that ontology has been divorced from logic and the history of Western metaphysics for Heidegger.

Part I: Heidegger and logic

I.   The meaning of *physis*

F. E. Peters describes *physis* as the subject matter of *logos* (Peters, 1967, 158). Plato[1] and

Aristotle[2] call the early philosophers *physikoi*, meaning those who are concerned with *physis*.

Physis is sometimes translated as 'nature'.[3] F. E. Peters describes Heraclitus'[4] use of *physis* as "a

kind of internal organizational principle, the structure of things" (Peters, 1967, 158).[5] Apart

from Heraclitus, it has been used as growth, movement, increase, or 'the physical stuff in the

world'. In *Elucidations of Holderlin's Poetry*, Heidegger says *physis* does not merely mean

growth or an increase, but rather to emerge or disclose[6] (Seidel, 1964, 34).[7] Even when *physis*

does refer to growth[8] in early Western ontology, it does not only refer to evolution or mere

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[1] Phaedo 96a.

[2] Metaphysics 1005a.

[3] Heidegger believes that *physis* has lost its meaning in translation. *Physis* was translated into Latin as *natura*. Heidegger describes the meaning of *natura* as 'to be born' or 'birth'. In *An Introduction to Metaphysics* Heidegger writes "but with this Latin translation the original meaning of the Greek word *physis* is thrust aside, the actual philosophical force of the Greek word is destroyed" (Heidegger, 1959, 13).

[4] I mention Heraclitus because his notion of *logos* and *physis* is important in the development of the treatment of the two terms for Heidegger.

[5] Peters cites Heraclitus' fragment number 123.

[6] For Heidegger, the truth (and the truth of being) is hidden. It is concealed but can be disclosed or revealed. In his lectures from 1925-1926, he lists 5 different meanings of truth, all of which he says share the same "structure of *just-as* or *as-so*" (Heidegger, 2010, 8).

[7] *Physis* is, for Heidegger's purpose and according to Heidegger's interpretation, an uncovering (of the truth of being). He writes "*physis* is the process of a-rising, of emerging from the hidden, whereby the hidden is first made to stand" (Heidegger, 1959, 14-15).

[8] The relationship between growth and disclosure is this: when beings grow, some of their potentialities are actualized. Beings are permanently in flux, in a state of becoming, and they become what they had the potential to become. When a being is growing, its former potentialities are disclosing. In his lecture series titled An *Introduction to Metaphysics*, Heidegger writes "*physis* is the process of a-rising, of emerging from the hidden, whereby the hidden is first made to stand" (Heidegger, 1959, 14-15). He also writes "the Greeks did not learn what *physis* is through natural phenomena, but the other way around" (Heidegger, 1959, 14). He does not explicitly back this claim with concrete historical evidence, though. Although, this claim could make sense (solely) etymologically if *physis* is derived from the PIE (Proto-Indo European) root *bheuə- — meaning 'to be', 'to grow'. This would mean that greek *phusika* (meaning 'physics' and which is derived from *physis* and as such) traces back to the PIE root *bheuə- (Houghton, 1997, 1031 and 1588). So, Heidegger's claim arguably receives merit from etymology, if natural phenomena (*phusika*) comes from a root meaning 'to be', 'to grow'.

becoming, but rather to 'coming out' or 'coming into the light', that is: unconcealment[9] (Seidel,

1964, 34).[10] Un-concealment is to dis-cover what is the case, what is true. When *physis* emerges

(from hiding), it "stands in *unconcealment, alētheia*" (Heidegger, 1959, 102).[11]

II.   The meaning of *logos*

The Greek *logos* has been used in different ways and its usages have changed throughout

history. In *An Introduction to Metaphysics*, Heidegger writes that the root word of *logos* is

legein (Heidegger, 1959, 124).[12] *Legein* refers to collecting, gathering, or bringing together

(Heidegger, 1959, 124).[13] It can also refer to counting (Kaczyńska). Both the collecting and the

togetherness (i.e., the stuff that has been collected together) is one of the descriptions of *logos*.[14]

Legein, in its historical linguistic development, came to mean 'to speak' (Heidegger, 1959, 128).

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[9] Unconcealment or disclosure is the notion (or at least a notion) of truth for Heidegger and the ancient Greeks. Truth is known when being is being unconcealed and is coming into the open to be seen. In *Being and Time*, Heidegger writes "Being-true (truth) means to-be-discovering" (Heidegger, 1996, 201). It is not the case that beings fully come out of hiding; rather, when a being's being is unconcealing, it is also concealing. Heidegger writes 'the "being-true" of *logos* as *alētheuein* [truthing or the process of the revealing of truth] means: to take beings that are being talked *about* in *legein* as *apophainesthai* [appearing or bringing to light] out of their concealment; to let them be seen as something unconcealed (*alēthes*); to *discover* them' (Heidegger, 1996, 29).

[10] Heidegger writes *physis* "denotes self-blossoming emergence… ,opening up, unfolding, that which manifests itself in such unfolding and preserves and endures in it" (Heidegger 1959, 14).

[11] For the purpose of this paper, *physis* will be used as in emergence or growth.

[12] In PIE, *leg- means 'to gather' or 'to collect'. Although, the philologist Elwira Kaczyńska argues that in Italic, Greek and Old Indic, *leg- was originally *sleg-. She says the *s- could have been an s-mobile — meaning that *s- appears in front of the root *leg (as *sleg-) *sometimes* but not all the time. Kaczyńska says the original cluster *sl- was simplified to Latin l- and Greek λ- (Kaczyńska, 2016, 154). Kaczyńska argues the Indo-European *sleg- is derived from the PIE root *les- — meaning 'to collect' or 'to gather'.

[13] Some PIE words with the root *leg- — as in the German *lesen* and the Latin *legō* — also refer to 'read' (as in reading a book and gathering information) (Kaczyńska, 2016 154). The Latin *legō* also refers to law, rule, or regulation or resolution (as in a collection of legal rules or principles) (Kaczyńska, 2016 153). The German *lesen* and the Albanian *mbledh* also refer to agriculture: harvesting (gathering crops), picking (collecting) grapes to make wine, cleaning up crops (Kaczyńska, 2016 153 and Heidegger 1959, 124). Albanian *mbledh* can mean "collect/gather one's wits" or "add together" or "add up" (Stefanllari, 2000, 76 and 2).

[14] In *An Introduction to Metaphysics* he writes "'in *Physics*, θ I, 252 a 13, Aristotle says: *taxis de pasa logos*, "all order has a character of bringing together"' (Heidegger, 1959, 125).

This was a usage of *legein* by Heraclitus' time; thus, Heraclitus writes of 'listening to the *logos*' (fragments 1 and 50, for example) (Robinson, 1987) (Heidegger, 1959, 128). Heidegger interprets Heraclitus' usage of *logos* as meaning both togetherness (collectedness) and speech: *logos* speaks[15] and it speaks of being (Heidegger, 1959, 128). *Logos* has the quality of togetherness; the gathering of being is *logos*. Being is gathered in *logos*.

Pre-Socratic philosophers had used *logos* differently than later philosophers. Richard Kearney describes *logos* in ancient Greek philosophy when he writes (Kearney, 1994, 41-42):

By *logos* the pre-Socratics understood not some logical correlation between objects, but a hidden ontological attunement (*harmonia*) of the Word of human thinking (*logos* as *psyche*) and the Word of Being (*logos* as *eon*). Heraclitus could affirm accordingly that *logos* remained irreducible to a purely anthropocentric framework: "If you have heard not me but the *logos*, then it is wise to say — all is one". Post-Socratic metaphysics, by contrast, reduced the *logos* to logic and made of thinking a matter of correct judgment — a matter of adjudicating Being reductively in terms of the categories of technical thinking.

For Heraclitus, *logos* is an inherent substrate of our world. F. E. Peters writes that for Heraclitus, "*logos* is an underlying organizational principle of the universe" (Peters, 1967, 111). According to Heidegger's interpretation of the pre-Socratic notion of *physis*, *physis* is the revealing of being which gets expressed through *logos*. *Logos* describes *physis*.[16] In the description of *physis*,

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[15] *Speech* here does not refer merely to verbal talking. Heidegger interprets this speech as something that can be understood by a person if they are listening; by *listening*, Heidegger does not refer (only) to physiological listening, but rather he means listening to what *logos* (and *physis*, as Heidegger interprets the pre-Socratics usage of it) is saying: listening to the *logos* is being attuned to being and being with being.

[16] In *The Fundamental Concepts of Metaphysics*, Heidegger writes "φύσιν [*physis*] [is], the prevailing of what prevails; λόγος [*logos*] [is], the word, that which takes this prevailing from concealment"

physis can be 'heard'[17] in the *logos*.[18] For the pre-Socratics, *physis* and *logos* were intimately

related. Starting with interpretations of Plato, according to Heidegger, *physis* and *logos* have

become divorced for much of the history of Western metaphysics.

Plato's use of the term *logos* has been interpreted in a variety of ways. One way Plato

uses *logos* is in contrast to *mythos* (myth), whereas *logos* is referring to the true account. In the

Phaedo, Plato uses *logos* to refer to *account*, to give an account, or to explain what is the case.[19]

In *Theaetetus*, Plato uses *logos* as opinion (*Doxa*) partnered with *account*.[20] Later in Theaetetus,

Socrates describes *logos* as a thing's distinguishing characteristic(s).[21]

Aristotle has also been interpreted as using *logos* in a variety of ways. At times as

reason, rationality, or 'right reason' (especially regarding ethics). Other times *logos* has been

used synonymously with *horos* (definition or form) (Peters, 1967, 111). In parts of *Metaphysics,*

he uses *logos* as *mathematical proportion* (991b) (Peters, 1968, 111).

Stoic linguistic theory distinguished between interior *logos* and exterior *logos*, where the

former is *thought* and the latter is *speech* (Peters, 1967, 112).

(Heidegger,1995, 28). In *An Introduction to Metaphysics*, Heidegger identifies *physis* with *logos* as 'gathering' when he writes "*physis = logos anthrōpon echon* [human being has *logos*]*:* being, overpowering appearing [*physis*], necessitates the gathering [*logos*] which pervades and grounds being-human" (Heidegger, 175, 1959).

[17] For Heraclitus, *logos* is heard by listening to the world in one's lived experience. In *An Introduction to Metaphysics*, Heidegger writes "true hearing has nothing to do with ear and mouth, but means: to follow the *logos* and what it is, namely the collectedness of the essent itself" (Heidegger, 1959, 129).

[18] *Physis* is always revealing itself, however *logos* is not always heard, according to Heraclitus. *Physis* is only disclosed *if logos* is heard (Robinsonn, 1987, fragments 1 and 2).

[19] "'And do you think that everybody can give an account of the matters about which we have just been talking?'" (Phaedo 76b).

[20] Theaet says "He [by he, Theaet refers to 'someone', and this perhaps implies that Theaet has forgotten who the man was who told him this] said that knowledge was true opinion accompanied by reason, but that unreasoning true opinion was outside of the sphere of knowledge" (Theaetetus, 201 c-d).

[21] "Knowledge is the ability to tell some characteristic by which the object in question differs from all others" (Theaetetus, 208-c).

With the pre-Socratics, *logos* was the phenomenon that describes *physis* and describes truth. With later (after Socrates) thought, *logos* was treated as the 'correct statement';[22] *logos* for later philosophers is not grounded in truth or ontology; it is instead ontical[23] (Seidel, 1964, 30 and Kearney, 1994, 42).[24]

III.   Heidegger's project: overcoming metaphysics

Heidegger criticized the history of western metaphysics[25] for forgetting the question of being.[26][27] Western metaphysics is being accused of treating existence ontically as opposed to ontologically: Western metaphysics investigated beings but not Being.[28] Beings are what things

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[22] Heidegger writes "initially the logos as gathering *is* the event of unconcealment, grounded in unconcealment and serving it. Now, logos as statement becomes the abode of truth in the sense of correctness. And this process culminates in Aristotle's proposition to the effect that logos as statement is that which can be true or false" (Heidegger, 1959,186).

[23] Ontic refers to beings or entities; ontology refers to Being. The positive sciences are *ontical* in that they observe the surface of things. An example of an ontical discipline would be experimental psychology — which uses the scientific method to reach conclusions on the human psyche. Research in experimental psychology is superficial in that it examines the end result of what people do, without taking into account ontological factors (such as *facticity*, for example). Furthermore, experimental psychology assumes that (the 'psyche' is a thing that exists, and) the results of the human behavior that seem to appear from experiments are directly caused by or related to the psyche. A discipline contrasted to the positive sciences would be phenomenology, which is doing *ontology* in that it investigates the *Being* of human beings and not just how human behavior appears on the surface from an outside observer. See the next section for more on the distinction between ontic and ontology.

[24] This claim — the claim that *logos* in later philosophy is not grounded in truth or ontology — is made by Seidel and Kearney.

[25] Seidel writes that in Heidegger's later work, 'metaphysics' has a negative connotation. Seidel writes that in *Being and Time*, Heidegger writes of the "destruction of the history of ontology" (Seidel cites *Sein und Zeit* pp. 19 ff.); in his later terminology, however, Heidegger would have used the word metaphysics instead of ontology. In his later terminology, Heidegger used 'metaphysics' to refer to the philosophy that forgot being, opposed to 'ontology' — which is being itself (Seidel, 1964, 30 in footnote 16).

[26] 'The question of the meaning of being was not only unresolved, not only adequately formulated, but in spite of all interest in "metaphysics" has even been forgotten' (Heidegger, 1996, 19).

[27] For Heidegger, the authentic truth of being can be found in the pre-Socratics — where truth was disclosed but then soon concealed. The authentic truth of being can also be found, for Heidegger, via a phenomenological investigation of human being — something which Heidegger attempts throughout his career (most famously in *Being and Time*).

[28] Being is sometimes written with a capital 'B' and beings with a lowercase 'b'.

are; Being is *how* a thing (beings) exists. Ontic (beings) refers to mere entities; ontology (Being) is the meaning of beings.[29]

a. Heidegger on *logos* and logic

In his lectures published under the title *Logic: The question of truth* and *The Metaphysical Foundations of Logic*, Heidegger stresses the need for logic to become philosophical again (Heidegger, 2010 and Heidegger, 1992).[30] He repudiates privileging formal logic as a method of investigating the truth of being, arguing that it contains no philosophy. All school teachers do, "year after year, is parrot the same old stock of unchanging, shopworn propositions, formulas, rules, and definitions" which students merely memorize (Heideger, 2010, 10). There is no philosophizing or "serious questioning and investigation" going on (Heidegger, 2010, 10). As such, formal logic eradicates ontological considerations; or, logic has 'forgotten' the question of being.

Formal logic is thought of as a way to investigate truth and furthermore, the laws of a formal logic themselves are set in stone and treated as true. Formally logical laws are timeless,[31] as opposed to being grounded in time;[32] instead of letting truth reveal itself, the apparatus that is

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[29] The difference between Being and beings is referred to as the *ontological difference* by Heidegger. As Michael Wheeler explains it, the ontological difference is the difference "between the ontical and the ontological, where the former is concerned with facts about entities and the latter is concerned with the meaning of Being" (Wheeler).

[30] "'Scholastic logic' is not philosophy' (Heidegger, 2010, 10). "So this is the challenge: logic should change; logic should become philosophical!" (Heidegger, 1992, 5).

[31] Time grounds being, for Heidegger; as such, if logic is timeless, it cannot investigate being. He writes "because being is in each case comprehensible only in regard to time, the answer to the question of being cannot lie in an isolated and blind proposition. The answer [to the question of being] is not grasped by repeating what is stated propositionally" (Heidegger, 1996, 17).

[32] To clarify, human existence is temporal for Heidegger *not* because existence is *in* temporality, but rather because temporality is in the very ground of existence. *Care*, *projection*, *happening* and the other characteristics which constitute Dasein's being are necessarily grounded in temporality. In *Being and Time*, Heidegger writes "confirmation is to be found for temporality in all the essential structures of the fundamental constitution of Da-sein" (Heidegger, 1996, 305). Or, as George Seidel describes this idea:

formal logic manufactures an unambiguous, timeless 'truth'. In *Being and Time*, Heidegger, speaking on formal "systems of relations," says "such formalizations level down the phenomena to the extent that the true phenomenal content gets lost" (Heidegger, 1996, 82). Heidegger's critique of formal logic is essentially the same as his critique of the history of Western metaphysics: ontology has been forgotten.

Heidegger writes that "the subject matter of logic is *speech*"[33] and "logic investigates speaking" (Heidegger, 2010, 6). For Heidegger, logic is the science of truth and truth is revealed by speech or in-speaking. For Heidegger, logic and language are connected (as Heidegger thought it was for the ancient Greeks).[34] He writes "in such acts of revealing, whatever one is speaking about shows up, becomes perceivable, and, as something perceived, gets defined in and by the discussion about it" and "language, speaking, thinking: they coincide as the human way of being" (Heidegger, 2010, 6). Speaking is fundamental to being human. Speech is how beings are uncovered and when they are, their truth is revealed (see footnote 6) (Heidegger, 2010, 6).

IV.   Problems with *a logic*

Examples of *a logic*[35] are not limited to a formal logic; Hegelian logic, Mill's method of induction, and Popper's falsification are also examples of *a logic*. In its attempt to formalize

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Dasein "does not live *in* time; rather, he *lives* timely" (Seidel, 1964, 21 in footnote 37). Non-human things have no history for they only have temporality in relation to Dasein's temporality; non-human things themselves do not have their own temporality. Temporality (and thus history) of non-human things are only possible through and because of *Dasein's* temporality.

[33] In this quote and in this paragraph, 'logic' does not refer to formal logic; this paragraph is devoted to Heidegger's normative description of 'logic'.

[34] He writes "among the Greeks logic developed in connection with grammar understood as the study of language" (Heidegger, 2010, 5). 'In fact,... [logic and language] were so *in*distinct that the Greeks lacked a word for what we call "language"' (Heidegger, 2010, 5).

[35] By the term '*a logic*', I refer to any system that has a defined set of laws that are meant to be universally applied to the world to analyze truth.

ontology (even if it be a regional ontology; Popper's falsification, for example, deals with the

regional ontology called 'science') via reducing ontology to a system of rules, laws or formulas,

which are tools for evaluating truth, *a logic* does not deal with ontology at all; rather, it is tasked

with beings and their ontical relation to each other. *A logic* could never be 'correct' or 'true'

because any attempt to formalize being would necessarily exclude some of being. *A logic* is a

determinate being[36][37] and as such it *conceals* beings as opposed to *revealing* the truth.

Heidegger's interpretation of the pre-Socratic use of *physis/logos* stands in contrast to *a*

logic. This interpretation of *physis/logos* is not *determined* and thus is not closed-off from all of

what it negates; this interpretation of *physis/logos* encompasses all of being.

a. Problems with *a logic*: the Ravens paradox

The Ravens paradox (also known as the Raven's problem or Hempel's paradox) was put

forth by Carl Hempel and has been debated by different thinkers from different views (namely

I.J. Good and Nelson Goodman). It is said in a formal logic that if a hypothesis is true, then its

logical equivalence must also be true.[38] Hence, in his article *Studies in the Logic of*

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[36] Hegel's logic starts with his concept of being or *pure being*. When all content and properties are abstracted from the world or no properties are ascribed to the world, what is left is everything, yet nothing; this idea of a property-less world is called *pure being* for Hegel. Hegel says that *pure being* is identical with nothing or *pure nothing*. In the *Science of Logic* he says that *pure being* "would not be held fast in its purity if it contained any determination or content which could be distinguished in it or by which it could be distinguished from an other" (Hegel, 1996, 82). *Determinate being*, for Hegel, then, is a being which *does* have qualities. A *determinate being* may be thought of as a *thing* or a *distinct* thing with properties, as opposed to nothingness or everything. Part of a *determinate being* for Hegel is that a *determinate being* has a negation. Another way of thinking about it is that *determinate being* is (a) 'something' and not (a) 'something else'. A plant (which is a *determinate being*,) is not a tree, a shirt, a human or anything else (these 'anything else' are in themselves *determinate beings* with their own qualities and negations). A *determinate being* is all that which it is not, or as Hegel and his followers sometimes put it: a *determinate being* is the negation of its negation.

[37] *Determinate* in Hegel is the translation of the German word *Dasein*. Although, Hegel uses *Dasein* differently from Heidegger.

[38] While describing the Ravens paradox, Peter Godfrey-Smith describes the idea of logical equivalence: "any evidence that confirms a hypothesis *H* also confirms any hypothesis that is logically equivalent to *H*.

Confirmation, Hempel writes that the statement "all ravens are black" must be logically equivalent to the statement "whatever is not black is not a raven" (Hempel, 1965, 12). He writes the two statements in first-order logic:[39]

$$S_1: \text{'(x)[Raven(x)} \supset \text{Black(x)]'};$$

$$S_2: \text{'(x)[\sim Black(x)} \supset \sim \text{Raven(x)]'}$$

If this is true, observing a white shoe — which is not black and not a raven — would make it true that all ravens are black. So, if a white shoe is observed, this would suggest that all ravens are black.

The equivalence of these two hypotheses is figured by a logical formula, but it does not make empirical sense.[40] The logical reasoning put forward by Hempel in his paradox is an example of formal logic being ontical, abstract and ultimately incapable of finding truth. In formal language, the Ravens paradox is not a paradox and it is only through rationality and empirical observation that disproves this logical 'truth'. By use of logical rules only, it is regarded as 'true' that if someone observes a white shoe, then all Ravens are black.

Part II: Mathematics

V.   *Abstraction-and-application*

In the hard and social sciences, ontic philosophies, formal logic and mathematics, there is a theme of *abstraction-and-application*: beings are observed, principles about beings are *abstracted* from them, and these principles are *applied* back to those beings to investigate truth.

… if *H* is logically equivalent to *H**, then it is impossible for *H* to be true but *H** false, or vice versa" (Godfrey-Smith, 2003, 46-47).

[39] The following is Hempel's exact language, including the single quotes and semicolon.

[40] Non-black ravens have been observed.

Aristotle arrived at his findings in his natural philosophy through everyday experience.

Aristotle's proposition that heavier objects fall faster than quicker objects was widely accepted

for centuries until Galileo's law of falling bodies. Aristotle observed the world and formed,

abstracted, laws of it. Once the laws were established, they were *applied* back to the world.

Galileo did the same: came to a conclusion about falling bodies and wrote it down as a 'law' to

then be applied to future falling bodies.[41]

In formal logic, *abstraction-and-application* take place when 'laws' of existing (ontic)

things are created and then applied back to the subject matter that formal logic investigates. The

idea of classical logic is to investigate truth via its laws that are permanently defined before any

investigation takes place. Classical logic assumes its laws are true absolutely.

Abstraction-and-application can investigate ontic truth, but not ontological truth. Classical logic

[42] assumes the law of the excluded middle, that any proposition is either true or its negation is

true. This law is not clearly true, though. There are logics that reject the law of the excluded

middle (intuitionistic logic,[43] for example). There are certainly instances where a proposition is

not either true or false. There can be instances where a proposition can be: a) known to be true

or false but it can be unable to know which, b) not able to be known whether or not it is true or

false, c) partially true and partially false, d) relative to something, e) any combination of any of

these.

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[41] The significance of Aristotle and Galileo here is only to give an example of a hard science (physics in this case) as a historical series of proposed laws formulated via *abstraction-and-application*.

[42] 'Classical logic' is one of the more prominent logics. One of the axioms of classical logic is the law of the excluded middle (Lovas).

[43] 'Intuitionistic logic' is a non-classical logic developed by L. E. J. Brouwer in 1907 and 1908. It rejects the law of the excluded middle (Moschovakis).

Phenomenology aims to get away from a process like *abstraction-and-application* as this method (the method of *abstraction-and-application*) produces theories that are not ontological, but rather ontical. In the first half of *Being and Time*'s introduction, Heidegger explicates how scientific knowledge develops. He writes "the totality of beings can, with respect to its various domains, become the field where particular areas of knowledge are exposed and delimited. These areas—for example, history, nature, space, life, human being, language, and so on—can in their turn become thematized as objects of scientific investigation" (Heidegger, 1996, 7). In other words, scientific fields of investigation may be isolated, *abstracted,* from being ("Being," *Sein*, for Heidegger).

VI.   Returning mathematics to ontology

Mathematics is another subject that contains the process of *abstraction-and-application*. An aspect of being is that it contains mathematics;[44] *physis* is mathematical because mathematics is *grounded* in *physis*.[45] Mathematics' manifestation is always present, always operative. Mathematics — manifesting as phenomena joining together, moving apart, multiplying, being grouped together, being counted, etc. — can always be experienced in *physis*. Consider the mathematical implications of Plato's *Parmenides*. Although Plato is writing before the advent of set theory, Socrates is doing naïve set theory in Plato's *Parmenides* when he speaks of forms. Responding to Zeno at 129 d, Socrates argues there are "forms, themselves by themselves, of the things I was talking about a moment ago—for example, likeness and unlikeness, multitude and oneness, rest and motion." Then, Parmenides questions Socrates about the "form, itself by itself,

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[44] In *Being and Time*, Heidegger writes "what *mathematics* makes accessible in beings constitute their being" (Heidegger, 1996, 89).
[45] To clarify here, *physis* means emergence or growth as it appears *to me*.

of just, and beautiful, and good… [and] human being, or fire, or water… [and] hair and mud and

dirt" and things that are similar to the things mentioned (Plato 130 b-c). The theory of forms can

have at least two set-theoretic interpretations: a) each thing (good, water, hair, etc.) listed as a

unit set[46] or b) each thing listed as a set with all of the phenomena exemplifying the thing being a

member of the set (for example, a beautiful person would be a member of the set of beauty, an

instance of justice would be a member of the set of justice, and my hair would be a member of

the set of hair). Sets cannot ontologically explicate forms, though; sets can only ontically

describe forms. Plato's forms (of justice, beauty, hair, etc.) exhibited as sets is only possible

through Being.[47][48] Fundamental ontology founds mathematics. Mathematics manifests in *physis*

and is only made distinct from *physis* when it is *abstracted* and treated as an isolated area of

phenomenon or study.[49]

From the experience of mathematics-in-*physis*, self evident axioms are revealed and

realized (or 'heard') in the *logos*. Once mathematics is revealed as a property of being,

mathematics can be *abstracted* into mathematics proper.[50] Once *abstracted*, mathematics is

treated *not* as a property of being among all other properties of being, but rather a *determinate*

being that is negated from all that it is not. Mathematics, which has been *abstracted* from being,

can now be *applied* back into being. Once principles of mathematics proper are accepted as true,

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[46] A 'unit set', also known as a 'singleton', is a set with only one member.

[47] The set of the form of justice, beauty and hair originates with the lived experience of these forms. For example: a) having justice served to you or engaging in political activity to struggle for justice; b) appreciating the beauty of an artwork or woman; c) having hair, taking care of (cutting, styling, washing, etc.) it and sharing having hair with other beings that have it; etc. and all that these things ontologically entail.

[48] The argument that Being founds mathematics — in this example, being founding Plato's forms as sets — refutes idealism, realism, and other philosophical schools.

[49] This isolated area of phenomenon or study is 'mathematics propper' (see footnote 50).

[50] 'Mathematics proper' does *not* refer to mathematics-in-*physis*, but rather to what mathematicians study. Mathematics proper is the field of mathematics as it is studied at schools or research centers.

they can then be applied to *nearly* any, if not *all* phenomena through numbers (quantity),

measurement (of space or time), sets, addition and subtraction, multiplication and division, and

so on.

VII.   The process of the *elevation* of mathematics

Once mathematics proper is *abstracted*, it becomes a *determinate being* and is a distinct

thing from *physis*. As a *determinate being* which is now an *abstract* entity, mathematical

investigation can now be manipulated by idealities and restricted by formal reasoning.

Investigation of mathematics proper has two components (among other components): one is

artistic and idealistic; the other is formal (as in strict rules and formal language). Both contribute

to the *elevation*[51] of mathematics from its *grounding* in *physis*; that is,

1. the aspect of mathematics proper that is artistic and idealistic (perfect lines and shapes,

     for example) does not portray mathematics-in-*physis*, but rather an idealistic

     representation of mathematics-in-*physis*. And

2. the formal aspect (*formal-axioms*[52] or formal proof techniques, for example) of

     mathematics proper may misguide the investigation of the truth of mathematics-in-*physis*.

In *Being and Time's* introduction, Heidegger says all sciences are founded and depend on basic

concepts or laws; upon them, structures and superstructures are built. A system of axioms,

however, does not facilitate the disclosing of the truth of being; rather, axioms can delimit

investigation and cover truth. Heidegger writes:

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[51] *Elevation* meaning that mathematics loses its *grounding* and becomes a theoretical study with no ontological *grounding*.

[52] By *formal-axioms*, I refer to the formalized and accepted axioms of mathematics that mathematicians use. ZFC or the Peano axioms would be examples of *formal-axioms*.

The elaboration of the area in its fundamental structures is in a way already accomplished by prescientific experience and interpretation of the domain of being to which the area of knowledge is itself confined. The resulting "fundamental concepts" comprise the guidelines for the first concrete disclosure of the area (Heidegger, 1996, 7).

When considering (the scientific area that is) mathematics, this means *formal-axioms* are 'pre-scientifically experienced'. Heidegger later writes of 'foundations' of a given science, writing that the science's ability to progress depends on its basic and fundamental concepts, its foundation, its axioms.[53] Writing on specific sciences, Heidegger writes that (at the time of *Being and Time*)

theology is slowly beginning to understand again Luther's insight that its system of dogma rests on a "foundation" that does not stem from a questioning in which faith is primarily and whose conceptual apparatus is not only insufficient for the range of problems in theology but rather covers them up and distorts them (Heidegger, 1996, 8).

In other words, in aiming at investigating mathematical truth, axioms do not reveal truth, but (due to axioms' inability to completely reveal) *can* distort and conceal truth. Later, Heidegger writes "the question of being… aims at an *a priori* condition of the possibility not only of the sciences which investigate beings of such and such a type… [but] it aims… at the condition of the possibility of the ontologies which precede the ontic sciences and found them" (Heidegger, 1996, 9). That is, fundamental ontology founds science; science is only possible because of Being. If true, fundamental ontology founds mathematics.

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[53] "A science's level of development is determined by the extent to which it is *capable* of a crisis in its basic concepts. In these immanent crises of the sciences the relation of positive questioning to the matter in question becomes unstable" (Heidegger, 1996, 8).

With the *elevation* of the truth of mathematics proper due to artistic/idealistic and formalistic distortion, mathematics is no longer in *physis*; mathematics is no longer in its *ground* but rather it is *elevated* from its *ground*. When mathematics is *elevated*, it is now a theoretical science and its investigation is subject to idealities and limited to formal rules.

a. Art and ideal

The search for a mathematical proof consists of creativity as much as it consists of strict rule-following. There are different methods of proof and writing a proof consists of trial and error and juggling with the different logical possibilities. At times, mathematicians may even create new definitions for mathematics as they go along (see the section below on 'Mathematical proofs' where Lakatos says this).

Aesthetic appeal has perhaps acted as a bias in the history of mathematical research. Zeno's space and time paradoxes indicated anomalies in Ancient Greek geometry, but Greek geometers looked past the paradoxes. They dismissed them as unsound as they searched for a more aesthetic and perfect 'truth' (Wilder, 1968, 8). Galileo discovered findings in set theory (Cantor later 'discovered' them, too) that he thought "ruined all hope of describing different sizes of infinite sets" (Crossley, 1972, 3). He thought that these findings must be meaningless. These instances show that in some cases, mathematical investigation can be affected by an aesthetic bias where mathematicians over-privilege beauty to truth.

b. Problems with *formal-axioms*

If the aim of the study of mathematics is to investigate the truth of mathematics proper, *formal-axioms* may distort truth in mathematics, for:

1. *formal-axioms* may not be identical with the true axioms of mathematics-in-*physis*;[54]

2. the likely limitations of *formal-axioms* will act as a paradigm for mathematicians to work in, making their research closed-off from intuition and thus promoting limited or biased research (that is, limited by or biased in favor of the set of axioms the mathematician is working with, familiar with, or tends to have a bias toward);

3. once *formal-axioms* are put forth and used in mathematical investigation, if the *formal-axioms* are used strictly, then mathematics becomes less so the study of shape, quantity, etc. *in* the lived experience, and more so like a game consisting of attempts to prove that given conjectures *fit in* like a puzzle piece to the larger system/game. If two different groups of people are both playing with a standard deck of cards, but playing two different games, the games will, of course, be different. Analogously, two mathematicians using two different sets of *formal-axioms* can arrive at different mathematical 'truths'.

It is in the ways listed in this section that the use of formal language and rules contribute to the *elevation* of mathematics.

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[54] *A logic* cannot encompass all of *physis/logos*. Likewise, *formal-axioms* may not encompass the truth of mathematics-in-*physis*.

c. Mathematical proofs

Mathematical proofs have similar problems that *formal-axioms* have. According to Paul Ernest, "mathematical propositions are fallible and corrigible and... published proofs are unreliable as they are very commonly flawed" (Howell and Bradley, 2010, 31). If a mathematical proof is sound, the conjecture that it proves still may be unprovable under a different proof method. In 1938 Godel proved two axioms: the Axiom of Choice and the Continuum hypothesis. In 1963 Cohen showed that the negation of these two axioms is unprovable (Crossley, 1972, 9-10). In *Proofs and Refutations*, Imre Lakatos argues that mathematics develops through dialogue. In the Stanford Encyclopedia of Philosophy dedicated to Lakatos, Alan Musgrave and Charles Pigden write 'attempts to rescue… [a] conjecture from refutation yield(s) "proof-generated definitions"... and "concept stretching"' (Pigden and Musgrave, 2016). In other words, in an attempt to prove a conjecture correct, or rather to save a conjecture from a refutation, mathematicians will invent new definitions to make the conjecture conform to a method of proving it (a method of proving it that did not previously exist before the mathematician invented new definitions).

VIII. Conclusion: mathematical truth is concealed as mathematics is *elevated* from its grounding in *physis*

In Heidegger's view, much of the history of Western metaphysics has lost its way because it has forgotten being: ontology has been left out of investigation. Ontology is left out of investigation of other fields of study too, such as logic and the positive sciences. I have argued that *a logic* can never be adequate for evaluating the truth of being as it cannot encompass all of

being or the pre-Socratic notion of *physis/logos*. *A logic* is instead an *abstract* entity that is distinct and apart from being. Likewise, mathematics proper is an *abstract* entity: mathematics is *grounded* in *physis*; once mathematics is *abstracted* from *physis*, however, it becomes an isolated subject in-itself (opposed to being in *physis*) to study; mathematics loses touch with being — with its *grounding* in *physis*. Mathematics is *elevated* from its *ground* when:

1. it becomes subject to artistic and idealistic manipulation (for example, lines are found in-*physis*, but an infinite and perfectly straight line, however, is the invention of the geometer), and

2. formalism (formal language and rules) restricts the investigation of truth in mathematics.

As the truth of mathematics is revealed in *physis*, it is then concealed when mathematics is *elevated* from *physis/logos* — in which it is grounded.[55] The more so *formal-axioms* and methods of proofs get out-of-touch-with-being[56] by relying on ontical reasoning, the more so mathematical truth gets *elevated* from *ground* and thus concealed. This criticism of mathematics follows Heidegger's critique of logic and the history of Western metaphysics: ontology has become divorced from questioning and ontic systems have filled its (ontology's) place.

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[55] Mathematics is a) revealed in *physis*, b) *abstracted* from *physis*, c) *elevated* from its *ground* (which is *physis*). When mathematics is *elevated*, it is concealed.
[56] *Formal-axioms* and proof methods necessarily are closed-off as they are *determinate beings* (opposed to being in *physis/logos*).

Appendix: Clarity to account for possible criticisms from idealism

This paper may be refuted by an idealist philosophy of mathematics, which may say that mathematical knowledge is innate and not known through experiencing mathematical phenomena in the world. An idealist philosophy may question how we can conceptualize an absurdly large number or a polygon with millions of sides, since they are not experienced in the world. In addition, idealism may argue that mathematics is true regardless of our senses,[57] which (senses) are perhaps an unreliable measure of reality, anyway. However, my paper does not claim to experience mathematical phenomenon in the form of absurdly large numbers and the like; my paper claims mathematical phenomenon is a part of the lived experience[58] and that axioms (but not the rest of mathematics) are apprehended and deduced from what seem to be the self-evident truths of phenomenon that fall under the domain of being called mathematics.

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[57] In his first meditation, Descartes says that regardless of what our senses tell us, the truth of mathematics is the same. "For whether I am awake or asleep, two plus three make five, and a square does not have more than four sides. It does not seem possible that such obvious truths should be subject to the suspicion of being false" (Descartes, 1993, 15).

[58] That mathematics is part of the lived experience cannot be doubted. For if so, beings or phenomena that contain any sort of mathematical property (number, sets, subtraction, addition, shape, space, etc.) could not exist. If this was the case, no being could exist.

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