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# The Analogy between the Infinity of the World and the Infinity of Mathematics in Relation to the Absolute

Cordelia Mühlenbeck
Medizinische Hochschule Brandenburg
– Theodor Fontane

**Abstract**

To analyze the infinity of the world and its cardinality and to show an analogy to the mathematical concepts of infinity, first, the metaphysical models which identify the world as infinite and describe it with the transfinite of mathematics, are examined. The reasons for their identification with the transfinite are pointed out and the cardinalities of these infinities are analyzed. It is then shown that the infinities of the transfinite are not sufficient to capture the cardinality of the infinity of the world. On the basis of the history of mathematics, the structuring of the infinite in set theory, its predecessors and extensions are described in order to show the connection between the world and mathematics and the arbitrary constructability of sets and classes. In both cases, the consistent application of the fundamental ontological principle of the relationship between *being* and entity results in absolute infinity, which in turn gives rise to the necessary foundation of *being*, both for the world and for mathematics.

**Keywords**: absolute infinity, absolute space-time continuum, infinity of the world, infinity of mathematics, reality of mathematical objects, philosophy of mathematics

## 1. Introduction

The aim of this text is to analyze the power of the infinity of the world and to show an analogy to the different concepts of infinity in mathematics. In more recent metaphysics, the transfinite of mathematics is used to capture the size and objectivity, but also the openness and contingency of the world in a new realistic ontology (Badiou 2005, 2019; Gabriel 2015b, 2015a; Meillassoux 2010). This ontology is described as continuous to the outside, without a primary substance or a primary system. This is attributed to the fact that every substance and structure, every entity, i.e. every uniformly combined whole, requires a determining background so that it can exist by separating from it. Heidegger already described this as the fundamental ontological necessity of the relation between every entity and its *being* (Heidegger 1989, 2010), from which the infinity of the world also followed for him (Heidegger 1967, 431). Examples of these recent metaphysics are the New Realism (Gabriel 2015b, 2015a), the Speculative Realism or Speculative Materialism (Badiou 2005, 2019; Meillassoux 2010), which have taken this principle as their basis. Since every 'ultimate' substance would need to have a defining background itself, it cannot constitute the ultimate all-defining substance. This means that standardizations such as: everything is matter, energy, consists of 'strings' or the 'quantum field' cannot represent the ultimate fundamental definition of the world. Any background can only function and exist as a background if it has itself the same existential relation to a wider background. These are the references of *being* as Heidegger described them and made them the basis of his fundamental ontology and its extensions (Heidegger 1975, 1989, 2000, 2010). However, the nature of *being* itself is not fully determined, since the references in space, time and possibilities are unlimited. That is, *being* itself is not an entity. The references that are made in *being* are always references to other entities in *being*. Thus, existence is not a property that is inherent in an object, but rather a property that we must always assume *a priori* in order to be able to consider an object at all. The resulting infinity of the world and its power (or cardinality) was deliberately described by Heidegger in an open way (Heidegger 1967, 431). This existential relationship is fundamental not only to existence in the world, but also to all operations in mathematics. We will consider the consequences arising from this relationship systematically in this text.

## 2. The necessity of different references of *being* - in extension, contingency and time

In mathematics, we can describe this need for the defining background with some results from set theory and the set operations within it. Suppose there is a set that should contain everything. 'Everything' becomes the elements of the infinite set. Then the set itself is also an element, which in turn is not included in the original set (Russell's paradox). Therefore the set cannot contain everything since it does not contain itself. Analogously, this argument is described as the impossibility of a closed world, because its seclusiveness requires a background against which it could be closed. This result is known as the fact that each power set of a set (i.e. the set of subsets of a set) is more powerful than the set itself. Since mathematics is the discipline that throughout its history has structured the infinite more and more deeply, we will use it to analyze the infinity of the world (or the infinite number of worlds) and its cardinality, after having identified the different necessary areas of *being*.

Let us first consider infinity in space and the expansion of objects in space. When we determine objects in their relation to their backgrounds, we run the risk of imagining these backgrounds as spatial and exclude time from this consideration. For convenience only, we will consider the connection between time and space later. In perception, an object is separated from the spatial background in order to distinguish it from it (figure-ground separation) and thus to recognize it as this object. But, all objects (also imagined ones) also have an extension in space itself, i.e. in order to recognize objects in perception (and imagination) *areas* have to be separated from each other. From the existentially necessary references of every entity to its *being*, i.e. from the delimitation of the areas from each other, it follows that these areas (of entities and *being*) must not only be delimited outwards but also inwards. The required plurality of structures and substances, as described above, initially suggests that they all exist in a parallel way, forming interrelated fields that determine each other, but that would result in a pattern that excludes the respective (additionally possible) structures and substances at individual areas, since they are only assumed next to the areas. Then again, we would receive, though chaotically, a form of structure, that has restrictions in the spatial forms of the individual areas. Hence, we must allow structures, forms and substances in each possible spatial area, no matter how small the area. Second, *being* does not only determine in a spatial way. Now, besides all possible areas, inside and outside, that form backgrounds against which we can let our recognized figure emerge, each one defining characteristics of the figure in its own way, we cannot exclude the realms of time and contingency, i.e. different possibilities. Otherwise we would again draw boundaries - like the world as the ultimate total object, or atoms, strings, quantum units as the ultimate building substance - of which it would be required that they are not defined by anything else. As a first result, we can state that the existing infinity of any realm is an actual infinity, it is a material continuum without any smallest or discrete particles or substances, and possibilities and time have to be combined with spatial extension. One objection could be that it makes no sense to look at things below the Planck length. Rudy Rucker describes in his 2019 edition of *Infinity and the Mind*:

"One hears that it's meaningless to speak of space at levels smaller than $10^{-35}$ meters. And some even say that space itself is tessellated into indivisible lumps. Ah, the myopic fear of infinity! First comes a call for finitistic austerity, then a grudging admission that granular space doesn't quite make sense, and then comes the lilting injunction: 'Be happy! The universe is incomprehensible! How wonderful!' To me, incoherence isn't wonderful. It means your theory isn't done. Reality comes first. Theories come second. The world arises on its own, and our opinions don't limit what the cosmos can do. Brave words, but how am I going to preserve our absolute continuum in the face of quantum mechanics? Well, let's suppose that the quantum level is like an interzone, or a glitch, or a rumble strip. We can trundle right through it. And beyond, or beneath, the quantum layer we enter what I like to call the subdimensions. According to the viewpoint I'm describing, our physical space has subquantum, subdimensional levels that allow space to be an absolute continuum." (Rucker 2019, xi)

That means, physical immeasurability does not result in ontological impossibility. On the contrary, the ontological, existential necessity results in an incompleteness of physical theories. Let's consider these consequences of the necessary areas in a closer analysis. From the impossibility of the smallest particles a homogeneous absolute continuum (homogeneous not in the sense of complete uniformity, but in the sense of an actual continuum, i.e. without any discrete particles) follows, where even in the infinitesimal areas of any point of consideration everything possible is contained. There are no previously (in shape, size or texture) defined elements. The division of the continuum can be continued beyond the infinitesimals, whereby we obtain the hyperreal and surreal numbers (Rucker 2019, chap. 2), similar to the construction of increasingly powerful infinities outwards. With regard to the cardinality of the class of surreal numbers, it is possible that they even elude well-ordering and cannot be measured at all (Rucker 2019, 10). But, if we didn't have contingency and time (change), there would be a determinism for the quality and position of every entity, which would give us an object again, a kind of world-pattern without any further existential backgrounds in the directions of time and possibilities. This would require a rule to define this determinism, thus again a connected area of all areas. This means that every point in the material continuum must contain every cardinality of time (since there is no single time lapse, as we will see below), possibilities, forms, objects, etc. Sizes are only proportions in space, the nature regarding form and size can change arbitrarily through contingency and time. We consider the concepts of sets and cardinality in more detail through the history and philosophy of mathematics and the paradoxes that have arisen in connection with the consideration of infinity.

### 3. The history of infinity in mathematics

In our formation of (linguistic and other forms of) concepts, most concepts in direct communication describe closed objects, due to the fact that most terms are intended to describe properties of objects, which represent a selection from a larger set of possible properties (Mühlenbeck and Jacobsen 2020). This creates definitions, i.e. the distinction of objects from others, which in turn presents the objects as units and the properties as elements. This separation in units correspond to our current concept of the infinite in mathematics, which was established by Georg Cantor. As we compose the world from objects in our intuition, we compose sets from elements. Intuitively, the world is structured and formalized, and since the foundation of mathematics on modern set theory also in a strictly mathematical way. However, the division into elements was not always the conventional approach to analyzing reality. Before the systematization of set theory, continua were considered, also in mathematics, to be homogeneous. Conceiving the continuum as a set and excluding the original, undefined (or unformalized) continuum from the use of mathematics was not a necessity but a decision that was made with the emergence of modern set theory (Bedürftig and Murawski 2010, 275, 278-279). By identifying the continuum with the real numbers, the infinitesimal calculus was ruled out together with a naturalness to consider the infinitely small (Bedürftig and Murawski 2010, 279). The division of the continuum into discrete elements, and their identification with it, has also caused various paradoxes (e.g. Zeno's paradox) which cannot be solved within structured set theory. In contrast to the division into elements stays the consideration of the continuum by Aristotle, in whose consideration Zeno's paradox did not appear because the continuum could only be infinitely divisible and no identification with discrete points was assumed (Bedürftig and Murawski 2010, 161). But since, during that time, mathematics was part of the everyday surrounding world Aristotle wanted the actual infinity to be excluded from it and only the potentially infinite was permitted, which led to new problems and was no longer sufficient for mathematical applications. Therefore, Cantor's discoveries of actual infinities, and the subsequent extensions, fundamentally revolutionized and advanced mathematics. However, the division into elements raised the question of the cardinality of the continuum (the continuum identified with $\mathbb{R}$), which is the present continuum hypothesis, which in turn is based on the assumption that the continuum is a set, a division into elements (Bedürftig and Murawski 2010, 156). Problems arise in both perspectives, the classical homogeneous continuum of Aristotle's time and the contemporary continuum of set theory, which is identified with $\mathbb{R}$. In the first, the continuum is homogeneous and transcends contemporary paradoxes. Aristotle concluded from the paradoxes a strict restriction to the potentially infinite (Bedürftig and Murawski 2010, 162) and excluded the actually infinite by exclusively considering the human acts of division, which can only be potentially infinite due to the limited lifetime (Aristoteles 1829, 193 b 22 ; Tengelyi 2014, 496-497). But, the paradoxes also dissolve in the homogeneous, actual continuum through the movement of different areas on different size relations. The potentially infinite is not necessary for this and, on the contrary, has the problem that it cannot exist without an actually infinite background, because at any point in time, by excluding the actually infinite background, it consists of finiteness without a background. In the case of the second, we have the actual infinity, but due to the division into elements, we also have discrete points that are not divisible themselves and are therefore supposed to form a final limit that itself is not defined by a background (Bedürftig and Murawski 2010, 186; Mühlenbeck 2018, 2020, 2021). In order to be able to correctly describe the cardinality of the space-time continuum of the world, it must no longer be identified with discrete elements, as it is the case in mathematical operations. As described, even there, this identification was just a decision being made, not a necessity. And Gödel's incompleteness theorems (Gödel 1995, 30; Rucker 2019, Excursion Two), his work on the arbitrary constructability of sets (Gödel 1990, 254-270), but also on the extension of classical set theory (Cantor and Zermelo) through the introduction of classes (Gödel 1986, chap. 'On completeness and consistency') also show the inexhaustibility of the continuum in a mathematical way. Together with the work of von Neumann and Bernays, the von-Neumann-Bernays-Gödel set theory (NBG set theory) was developed, which solved old contradictions in the properties of sets through the development of classes and made it possible to form new proofs of consistency (Bedürftig and Murawski 2010, chap. 4.3.2). In this inexhaustibility of the (space-time) continuum lie the transfinite and infinitesimal sets, newer constructions such as the hyperreal and surreal numbers (Rucker 2019, 85) of mathematics, but also all possibilities and times (not as a linear time frame, but as all possible time-forms), which was also already described by Gödel (Kovač 2012). Gödel identified the universal class, which is the universe of all sets in NBG set theory, with absolute infinity, due to its unattainability (Wang 1997, 280-285) and put this principle of identifying the universal class with absolute infinity as the first fundamental axiom to the foundation of set theory (Wang 1997, 282-283). This leads to a synthesis between the infinity of the world, mathematics and the absolute, where they can all be identified with an absolute continuum, the absolute infinity, in which the formalized infinities of the mathematical set constructions are only approximations.

## 4. The absolute infinity of the world and of mathematics

In order to establish this synthesis, the homogeneous continuum, which was dominant in the mathematical view before Cantor, must be combined with the discrete actual infinity of the transfinite (including the classes) and the infinitesimals up to the hyperreal and surreal extensions. In addition, contingency and time must necessarily be included in the consideration of the cardinality of the world and our mathematical concept formations, i.e. the reality of mathematical objects and our ability to recognize absolute infinity must be examined. We will deal with each aspect sequentially.

The actual infinity: through the development of set theory, the systematization of sets and the study of their cardinalities, Cantor established not only a way to reveal the depth and size of the continuum, but also to overcome the potentially infinite. The systematization of sets and power sets as actual infinities has emphasized that these must be present everywhere, because the infinitely many levels of them each define necessarily existing domains in which mathematical operations take place. These domains must exist as actually infinite value sets, as otherwise the operations would be undefined, which is also known as Cantor's domain principle (Cantor 1932, Abschnitt VII, S. 410 f). In addition, Cantor's theorem states that the extension of domains is never complete, so the number of levels of infinities is itself infinite. The range over which a variable, even infinite, quantity varies must always be a well-defined range. We have already seen above, with regard to the problem of the potentially infinite, that every potentially increasing object, in every momentary consideration, would be a limited object, of which the exclusion of the actually infinite would require that it was not limited by anything else, but which contradicts the definition of limitation. Thus, Cantor recognized the potential infinity as no real infinity and the actual infinity as a necessary condition for the potential one. With this argument, the ontological potential infinity is also resolved in contradiction. The potential infinity is only a potential one in our consideration, since only in this we walk along a sequence.

Absolute infinity inwards and outwards: since objects not only need outer but also inner realms of *being*, infinity must continue outwards and inwards. They occupy space and thus also consist of space in their inner direction. Since we can divide the inner space into any number of elements, for which the same principle must apply, the inner space must also be homogeneously continuous. The reason is that the assumption of discrete, smallest particles, of which all objects should consist, creates a kind of uniform substance, which itself cannot exist, since the particles themselves are not supposed to have their own background. They are supposed to constitute the objects, but not to be constituted themselves. Discrete points, $\mathbb{R}$, cannot fill the homogeneous continuum. They pop out of it randomly when they are looked at, but can not cover it, or as Gödel described: "rather the points form some kind of scaffold on the line" (Rucker 2019, 82; Wang 1974, 86). In addition, the position and definition of foreground and background, i.e. what is entity and what is *being*, is not defined in advance. A constituting background is itself the object or entity of other backgrounds. And also the operation with infinitesimals, like any quantity consideration, is only a tool for approaching the depth of infinity. Therefore, the homogeneous continuum is also not conclusively covered by them. Further constructions of realms of numbers arise (hyperreal, surreal numbers, and maybe more in the future). Space-time areas are arbitrarily representable by transfinite sets and classes or by the infinitesimal, hyperreal, surreal, etc. (Bedürftig and Murawski 2010, 175). This means that the infinity of the outer and inner domains of an object does not differ, the power or cardinality is the same. It also follows from the domain principle described above that the homogeneous, i.e. absolute, continuum is also necessary within mathematics as a basis of *being*, because the elements of $\mathbb{R}$ and those of the infinitesimals behave like points placed in the absolute continuum. These points themselves need areas of *being*, by which they are constituted, because otherwise they would not exist and therefore could not constitute any further objects. "The (intuitive) continuum, it is shown here also mathematically, corresponds to an inexhaustible 'continuous space sauce'"[1], as Brouwer described it (Brouwer, quoted from: Becker 1954, 346). But this 'space-sauce' is not an indeterminate something (from which for example the different views of nihilism would follow), it is neither determined by a rule nor undetermined, because there would have to be a criterion also for indeterminacy. Instead, it is over-determined - *over* in the sense of infinitely determined. The homogeneous characteristic of the continuum, is not a 'homogeneous mass' or uniform materiality, but heterogeneous infinity. What is homogeneous is only the equality of each point of space with respect to its divisibility. All possible divisions in the continuum correspond to an infinite divisibility instead of an infinite dividedness.

Contingency and time: arbitrary possibilities (contingency) and change (time) form further necessary backgrounds, because without them every object would have a defined position on a certain place with certain conditions and temporal appearances. By the exclusion of time and possibilities there would be a determinism in quality or condition. However, time is not to be understood as a given independent time frame, as already described above. A linear time lapse, which creates an equally independent frame of reference for all objects, would be a structure, which would have to exist independently of space and entities, and in addition would be undefined itself. Also, time cannot be separated into discrete points, or restricted to one form or a somehow ordered structure, for the same existential reasons. The alteration of objects (entities) is included in the objects just like the space they occupy. Space and time form coherently and relatively, within the things, an absolute continuum. In this absolute continuum we do not receive one single time lapse as an actual realization, but in any point absolute infinitely many times (as equivalent to 'no time'), with all possibilities and spatial forms (Gödel 2023). Gödel described this as a consequence of his logical and cosmological models (Kovač 2012, 331). Through the necessary temporal and contingent actuality it is implied that every area contains everything else, also the alteration towards all other forms. Size relations are not predefined spatiotemporally, whereby every area, no matter how small, offers place for every imaginable universe: "I'm supposing that space is an absolute continuum, jam-packed with surreal numbers. And never mind about atoms or quantum mechanics—you can go on down and down. And sure, there might even be superclusters of galaxies down there—why not! There's room for everything amid the cascading levels of alefs." (Rucker 2019, xiii) By projecting the transfinite in all interior directions, we can re-relate all size ratios arbitrarily. Gödel's description of the actual existence of timelessness (i.e. actual existence of all time-forms) and of all possibilities was analogously described by Heidegger as a component of *being* through historical thrownness (Heidegger 1967, 135). Through time, qualitatively new things come into being, with different possibilities in *how* they alter, but without increasing or being added to. The new things are already part of the previous things. The success of Cantor's development of set theory (and later extensions) made previous ways of looking at things, such as the homogeneous continuum or the infinitesimals, obsolete without integrating them. Cantor's revolution consisted in grasping the mathematically actual infinity, the transfinite, by dividing it into elements. For him, as for almost every contemporary mathematician, there was a separation between the actual infinity of mathematics, the world and the absolute, i.e. the absolute infinity (Bedürftig and Murawski 2010, 70). According to this view, the infinity of mathematics and that of the world was present in the absolute infinity, but separate from it. As we have seen, however, every mathematical operation, every worldly object and every conceptual consideration needs absolute infinity as their necessary realms of *being*. Moreover, the absolute infinity is only truly absolute when it has no limitations in any respect. Therefore, this separation between world, mathematics and absolute does not exist. Rather, due to the described existential necessity it is more difficult *not* to consider absolute infinity than to assume it in every point of space, in spite of the irritating consequences.

## 5. Conclusions

From the above considerations we receive the following results regarding the infinity of the world, that of mathematics, their analogous relationship to the absolute and the possibility of their knowledge. When we can describe the world and its structures mathematically, what is the reality of mathematical objects and structures? As we have seen above, even within mathematics its structures are not ultimately determined, but always require further domains to constitute them (Rucker 2019, chap. Excursion Two). Mathematical structures successfully represent interrelationships of reality. But, structures in the world, like mathematical structures, are not the ultimate reality, as a radical form of Platonism assumes. Any structure or relation is only one possibility among many, including the possibilities arising additionally from contingency and time. From this for any structure, that describes the world, it follows that it cannot be the ultimate structure, but is part of its respective space-time and has emerged and will change together with it. Evolution is the consequence of the power and temporality of *being*. Even if we can recognize and reveal mathematical structures (Platonistically) as abstract entities, there must be a realistic connection between the world and mathematics, and thus also between Platonism and Realism, since mathematics is a natural science in addition to its structural-scientific property (Maddy 1988). Thus, mathematical structures have an abstract and formally describable reality as the relations between the things and even between superordinate structures, but they cannot be conceived as an independent structure themselves, since they are part of the respective space-time domains. The only thing that does not change is the fact that things interrelate with each other. The form of the relations, thus of the mathematical structures, is changeable. From the boundedness of mathematical structures, the conclusion is usually drawn that we cannot recognize or describe absolute infinity, because mathematical structures never exhaust the continuum, or because we cannot follow an infinite series in our perception (Aristoteles 1829; Kant 1966; Kreis 2015). This is invalid because in every finiteness we have already recognized it as a necessary condition. It is clear that, in consideration, going through a potentially infinite sequence we would never reach the infinity of the absolute continuum, because it also corresponds to a division into discrete elements. But instead, we can form open concepts that elude an elementary division. This is then the realization that any structure (like $\mathbb{R}$ or the infinitesimals) and any object is a contour within all possible realms of *being* of the backgrounds and foregrounds of the continuum. That means, with every cognition of a finite object or a finite structure the absolute infinity is recognized as a necessary component inevitably inclusive, because within it the figure of the object is separated from the ground. If we separate, in our observation, a figure from its ground, we cannot extrapolate from the finiteness of this act of intuition to a finite ontology, as e.g. Kant did in his Cosmological Antinomies (Kant 1966), or Aristotle in the potential infinity of the act of division in consideration (Aristoteles 1829, 193 b 22 ; Tengelyi 2014, 496-497). The things themselves do not contain any limitations in their *being* and the *being* is not bounded by our selection in intuition. Instead, objects can be viewed arbitrarily in different relations of *being*. Thus, we receive a metaphysical and concept theoretical pluralism that dispenses with presupposing uniform theories, ontologies or metaphysics and thus offers a maximally open access to reality that maps the cardinality of the infinity of the world and of the universal class in set theory and identifies both with absolute infinity.

NOTES

[1] Translation by the author. Quote in the original language: „Das (anschauliche) Kontinuum, so zeigt sich hier auch mathematisch, entspricht einer unerschöpflichen ‚kontinuierlichen Raumsoße'" (Brouwer, zitiert nach: Becker 1954, p. 346).

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**Cordelia Mühlenbeck's** research interests lie in the combination of phenomenology, meta-theory of psychology, philosophy of mathematics, metaphysics, ontology and the psychology of worldviews. Thus, she published articles in the fields of metaphysics and philosophy of mathematics, phenomenology and the psychology of symbolic cognition and worldviews.

**Address:**
Cordelia Mühlenbeck
Medizinische Hochschule Brandenburg – Theodor Fontane
Department Psychologie, Qualitative Forschungsmethoden Fehrbelliner Str. 38, 16816 Neuruppin, Deutschland
Email: cordelia.muehlenbeck@gmail.com