Marko Uršič
Philosophical Faculty, University of Ljubljana, Slovenia

Multiverse or Universe, after all?

On some epistemological issues of the concept of multiverse

(PowerPoint presentation slides)

Key Words: multiverse, cosmology, infinity, wholeness, mind,
David Lewis, David Deutsch, Max Tegmark, Georg Cantor, Immanuel Kant

A contribution to the seminar

“Physics and Philosophy”

Split, July 9, 2013

Abstract

In this paper the concept of multiverse is philosophically discussed, starting from two points:
1. the controversy between metaphysical “modal realism” (David Lewis) and “actualism” (Saul Kripke);
2. the four-level hierarchy of multiverses, proposed by the cosmologist Max Tegmark (2003).
Here we take into account especially Tegmark’s “Level-III”, i.e. quantum multiverse(s), and “Level-IV”, the “complete mathematical democracy”, the putative universal isomorphism between mathematical and physical structures.

In the first main part of this paper, a typical example of Tegmark’s Level-III multiverses is analyzed from the philosophical point of view: David Deutsch’s quantum multiverse as “the fabric of reality” (1997). Deutsch’s principal argument for the reality of quantum “parallel universes” is the existence of “shadow particles”, which he proposed in order to explain quantum interference phenomena in slit-experiments. But parallel universes entail heavy questions concerning identity: personal identity (*doppelgängers*) and identity of objects, of entities in general. It is interesting to note that in Deutsch’s updated version of his quantum multiverse (2011), the *meta*-physical background is rather shifted from “shadow particles” in parallel universes to “multiversal object(s)” in the unique multiverse which has its “measure” in the laws of quantum mechanics. However, in this updated picture and in spite of the key role of quantum decoherence, *other* universes of this still quite “baroque” multiverse *remain* “out there” (*where* indeed?) – and so the (un)famous problem of Schrödinger’s cat remains open as well.

The second, shorter part of this paper considers the assumption that multiverses (as sets of universes) might contain *infinite* – or even *transfinite* – number of their elements. This conjecture implies similar troubles as the “naïve” theory of sets: *paradoxes of infinity and self-reference*. In the conclusion, Cantor’s view of “the Absolute” is outlined, and it is compared with Immanuel Kant’s critique of infinite “totalities” which are just “ideas”, because they “transcend all possible experience”. From the point of modern cosmology, Kant’s critique has to be applied to the “highest” *Multiverse*, i.e. to the set of all universes and/or multiverses, which can be considered as the (new, updated) *Universe*, after all.

A controversy in the modal metaphysics between “modal realism” and “actualism”

David Lewis, "modal realism":

"…There are ever so many ways that a world might be; and one of this ways is the way that this world is. – Are there other worlds that are other ways? I say there are. I advocate a thesis of plurality of worlds, or *modal realism*, which holds that our world is but one world among many. There are countless other worlds, other very inclusive things. […] The worlds are something like remote planets […] There are so many other worlds, in fact, that absolutely *every* way that a world could possibly be is a way that some world *is*." (*On the Plurality of Worlds*, 1986, p. 2, underlined by M.U.)

Saul Kripke, “modal actualism":

"I will say something briefly about ‘possible worlds’ […] I argued against those misuses of the concept that regard possible worlds as something like distant planets, like our own surroundings but somehow existing in a different dimension, or that lead to spurious problems of ‘transworld identification’. [… Concerning] terminology, I recommended that ‘possible state (or history) of the world’, or ‘counterfactual situation’ might be better." (*Naming and Necessity*, 1972, p. 15-16, underlined by M.U.)

The “Multiverse Hypothesis”

There are two main *motives* for introducing the “Multiverse Hypothesis” (or the “Many-Worlds Hypothesis”), i.e., to postulate the existence of many worlds/universes in *physical* (meta)theories:

1) the problem of interpretation of quantum states (“superpositions” …),
2) the problem of the cosmological “fine tuning” of basic physical constants (“free parameters”).

Let me note first some remarks concerning pt. (2):

“Fine-tuning” is either real or apparent.

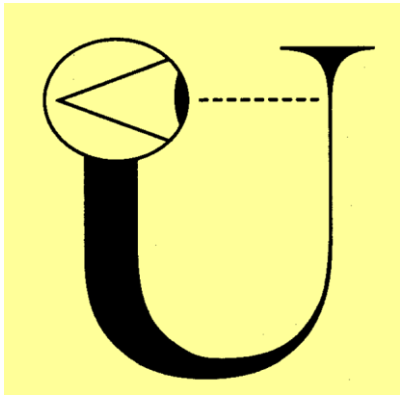
- In the first case, it should be the consequence of some kind of teleology of nature (transcendent or immanent),
- in the second case it could be, in principle, explained in two ways:
  - either by some future “Final Theory” or “Theory of Everything” (?)
  - or by the “Observation Selection Effect” which requires the “Multiverse Hypothesis”.

In cosmology, the latter option is also known as the “anthropic reasoning” which has been initiated by Brandon Carter (1974) with his “Anthropic Cosmological Principle”.

The “Anthropic Cosmological Principle”

Brandon Carter’s “Anthropic Cosmological Principle” (1974) has in its original formulation two versions:

- *Weak Anthropic Principle*: “We must be prepared to take account of the fact that our location in the universe is *necessarily* privileged to the extent of being compatible with our existence as observers.”
- *Strong Anthropic Principle*: “The Universe (and hence the fundamental parameters on which it depends) must be such as to admit the creation of observers within it at some stage. To paraphrase Descartes, *Cogito ergo mundus talis est*.”



“Cosmic Observer” (design by John A. Wheeler)

Hierarchy of multiverses

Max Tegmark is his paper "The Multiverse Hierarchy" (2003), which has been reprinted in *Universe or Multiverse?* (ed. Bernard Carr, 2007), classifies multiverses into four-level hierarchy, which progressively yields greater diversity of universes:

- "Level I: A generic prediction of cosmological inflation is an infinite 'ergodic' space, which contains Hubble volumes realizing all initial conditions – including one with an identical copy of you about 10 on 10^{29} power meters away.
- Level II: Given the *fundamental* laws of physics that physicists one day hope to capture with equations on a T-shirt, different regions of space can exhibit different *effective* laws of physics (physical constants, dimensionality, particle content, etc.), corresponding to different local minima in a landscape of possibilities.
- Level III: In unitary quantum mechanics, other branches of the wave-function add nothing qualitatively new, which is ironic given that this level has historically been the most controversial.
- Level IV: Other mathematical structures give different fundamental equations of physics for that T-shirt." (Tegmark, in Carr 2007: 99-100)

“Complete mathematical democracy”

Multiverses in Tegmark’s four-level hierarchy derive from:

I. different initial conditions

II. different “effective” physical laws

III. “parallel branches” in quantum states

IV. different “underlying” mathematical structures which give different fundamental physical laws.

Level-IV incorporates the idea of the “complete mathematical democracy”, which means that “a mathematical structure and the physical world are in some sense identical” (*ibid*. 116, underlined by M.U.)

– otherwise said, that “each physical entity [has] a unique counterpart in the mathematical structure and vice versa” (*ibid*. 117).

However, we might add, it would also mean that there is no “free mathematics” (in Cantor’s sense) at all.

Two main philosophical problems concerning multiverse(s)

The first *epistemological* (as well as ontological) problem of the multiverse theories, especially in cosmology, is its putative *simplicity*.

Tegmark's epistemological (in)version of Ockham's razor is quite typical for proponents of multiverse(s):

- "A common feature of all four multiverse levels is that the simplest and arguably most elegant theory involves parallel universes by default. To deny the existence of those universes, one needs to complicate the theory by adding experimentally unsupported processes and ad hoc postulates: finite space, wave-function collapse, ontological asymmetry, etc. Our judgment therefore comes down to which we find more wasteful and inelegant: many worlds or many words. Perhaps we will gradually become used to the weird ways of our cosmos, and even find its strangeness to be part of its charm." (Tegmark, in Carr 2007: 123-25, underlined by M.U.).

Another and to my mind an essential *methodological* problem of the multiverse theories emerges from the question where is the *limit* of the ascending hierarchy of universes and/or multiverses – does they rise up to *infinity*? (After all, infinity is much "simpler" in Tegmark's sense than some specific "googol number" …) – This is a problem concerning mainly the Level-IV in Tegmark's hierarchy, which I will discuss later.

A typical example of Tegmark's "Level-III" multiverse(s): David Deutsch's multiversal "fabric of reality"

Deutsch *meta*-physical starting point was **Hugh Everett**'s "many-worlds" *interpretation* of quantum mechanics (1957).

For **David Deutsch**, in his principal book *The Fabric of Reality* (1997), the main *physical* argument for the reality of "parallel universes" is the existence of "shadow particles" (as himself called them), which he proposed in order to explain queer *interference* phenomena, for example in the comparison between *four*-slit and *two*-slit experimental set-ups:

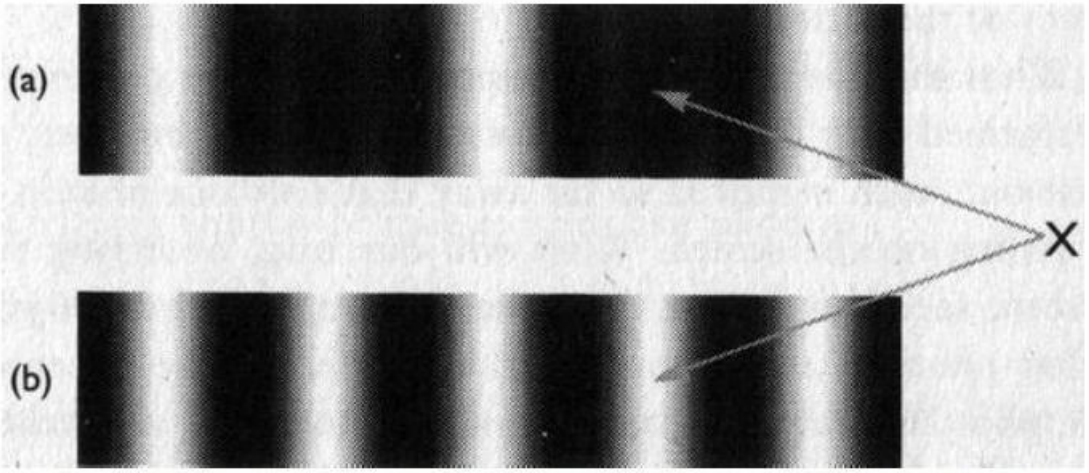


FIGURE 2.7 *The shadows cast by a barrier containing (a) four and (b) two straight, parallel slits.*

David Deutsch's "shadow photons argument" (main points)

In *The Fabric of Reality*, Deutsch wrote:

- "So, if the photons do not split into fragments, and are not being deflected by other photons, what does deflect them? When a single photon at a time is passing through the apparatus, what can be coming through the other slits to interfere with it?" (p. 43, underlined by myself).
- "… it does appear that photons come in two sorts, which I shall temporarily call *tangible* photons and *shadow* photons. Tangible photons are the ones we can see, or detect with instruments, whereas the shadow photons are intangible (invisible) – detectable only indirectly on the tangible photons [… However,] we shall see that there is no intrinsic difference between tangible and shadow photons: each photon is tangible in one universe and intangible in all the other parallel universes …" (p. 44).
- "It follows that reality is a much bigger thing than it seems, and most of it is invisible. […] We might think of calling the shadow particles, collectively, a *parallel universe* [… and there is] a huge number of parallel universes, each similar in composition to the tangible one, and each obeying the same laws of physics, but differing in that the particles are in different positions in each universe. […] A new word, *multiverse*, has been coined to denote physical reality as a whole." (pp. 45–46).

“Kicking back” as a principal criterion of physical reality?

“The heart of the argument is that single-particle interference phenomena unequivocally rule out the possibility that the tangible universe around us is all that exists.” (*ibi.d*., p. 47).

“If a photon is deflected, it must have been deflected by something, and I have called that thing a ‘shadow photon’.” (p. 49).

In Chapter 4 of *The Fabric of Reality*, titled “Criteria for Reality”, Deutsch postulates two main criteria: 1. the ability of something to “kick back”; 2. complexity of some entity. Here we look shortly just (1). Deutsch, in his refutation of “solipsism” (which he conceives rather broadly) says:

“… the criterion for reality that is used in science [is] namely, *if something can kick back, it exists*. ‘Kicking back’ here does not necessarily mean that the responding object is responding to being kicked – […] It is enough that when we ‘kick’ something, the object affects us in ways that require independent explanation.” (pp. 86–87).

“Neither the motion of Earth nor the presence of parallel universes is directly perceptible, but then neither is anything else (except perhaps, if Descartes’s argument holds, your own bare existence). But both things are perceptible in the sense that they peceptibly ‘kick back’ at us if we examine them through scientific instruments.” (p. 89).

Parallel universes and *doppelgängers*

Deutsch's def. **parallel universes**:

- "They are 'parallel' in the sense that within each universe particles interact with each other just as they do in the tangible universe, but each universe affects the others only weakly, through interference phenomena." (p. 53).
- "The quantum theory of parallel universes is not the problem, it is the solution." (p. 51).

But is it really a good solution? For what price?

Doppelgängers of *myself*, also named M.U.?

One of the "expenses" of a *real* multiverse (i.e., of a multiverse in the David Lewis' sense) are ***doppelgängers***, namely (my) "counterparts", which raise the question of personal identity, among other problems …

David Deutsch also asks *himself* : "But who are 'we'? While I was writing that [*The Fabric of Reality*], hosts of shadow Davids were writing too." (*ibid*., 53) … ?

Deutsch's more recent, rather altered views on multiverse

In his second large book, *The Beginning of Infinity* (2011), subtitled "Explanations that Transform the World", David Deutsch does not speak of "shadow realities" any more, nor he gives any explanation why so, however, there are surely some philosophical reasons behind such a shift.

The multiverse terminology is also slightly changed. Let us see the following definitions (Deutsch 2011, p. 303, underlined by myself):

- *the world* : "the whole of physical reality";
- *multiverse*: "the world, according to quantum theory";
- *universe*: "Universes are quasi-autonomous regions of the multiverse";
- *parallel universes*: "A somewhat misleading way of referring to the multiverse. Misleading because the universes are not perfectly 'parallel' (autonomous), and because the multiverse has much more structure – especially fungibility [*fungible universes* (or *histories*) are meant as "identical in every respect": to my mind this concept is quite problematic], entanglement and the measures of histories" [*histories* are defined as "sets of fungible universes, over time"].

Here it is quite obvious a conceptual (philosophical) shift from *plurality* of "parallel" universes to the *wholeness* and/or to the *unity* of "the world" – i.e., "back" to *the* Universe? – especially in Deutsch's stressing the importance of *measure* …

Measure and infinite multiverse(s)

Deutsch (2011) discusses the concept of *measure* in context of his criticism of bare "anthropic explanations" in cosmology; in Chapter 8, titled "A Window on Infinity", he points out that just a *statistical* application of the "Anthropic Principle" (say, in the manner of philosopher Nick Bostrom or, to a certain extent, of physicist Leonhard Susskind) is *not* sufficient, neither appropriate for explaining "fine tuning", *if* a multiverse (as a set of universes) – supposedly – contains an *infinite* number of elements, since without some physical ("dynamic") *measure*, without some physical order (or structure) in such a set, statistical probabilities of its subsets cannot be fixed.

Deutsch illustrates his point by the following ordering of natural numbers (see *ibid*., 176):

1 2 4 3 6 8 5 10 12 7 14 16 … (odd numbers are written here in red).

In this rearrangement of the natural numbers it just *seems* as if one-third of them were odd – as in their "usual" arrangement it just *seems* that the number of all odd (or even) numbers were just one-half of the whole set. The point here is that the frequency of the elements in some *finite* domain of an *infinite* set depends of its ordering.

Following Georg Cantor, we know that all numerically infinite sets have the same power – namely "Aleph-0" ($\aleph_0$) – however here, in Deutsch's critics of bare statistical "anthropic reasonings", his point is that the explication of any "fine tuning" in cosmology requires some *physical measure*, some physical structure in the multiverse set. And he states that such a measure is (at least for the moment) available only by the quantum theory, following Schrödinger equation etc.

So, Deutsch points out that the theory of quantum multiverse could be indeed an appropriate explanation of the (apparent) "fine tuning", but only by comprising both: observation selection effect (i.e. the "Anthropic Principle") + quantum theory as the "measure" of/in the multiverse.

Measure in an infinite multiverse

Concerning the above mentioned return of the concept of the *whole* in Deutsch's multiversal interpretation of QM, it is interesting to read the following passage (this quotation is longer, it seems to me quite important):

- "… And so *now* the anthropic principle can make testable, probabilistic predictions.

  What has made this possible is that the infinite set of universes with different values of *D* [i.e., of some relevant physical constant, "free parameter"] is no longer merely a set. It is a single physical entity, a multiverse with internal interactions […] that relate different parts of it to each other and thereby provide a unique meaning, known as a *measure*, to proportions and averages over different universes.

  None of the anthropic-reasoning theories that have been proposed to solve the fine-tuning problems provides any such measure. Most are hardly more than speculations of the form 'What if there were universes with different physical constants?' There is, however, one theory in physics that already describes a multiverse for independent reasons. All its universes have the same constants of physics, and the interactions of these universes do not involve travel to, or measurement of, each other. But it does provide a measure for universes. That theory is quantum theory." (Deutsch 2011: 180).

A “multiversal object” … but *doppelgängers* are back

As I have already mentioned, Deutsch (2011) has dropped his earlier metaphor of “shadow realities”. Instead he uses a new concept – “multiversal object” (*ibid*., 293):

- “Thanks to the strong internal interference that is continuously undergoing [in a quantum state], a typical electron is an irreducibly multiversal object, and not a collection of parallel-universe or parallel-histories objects. That is to say, it has multiple positions and multiple speeds without being divisible into autonomous sub-entities […] So the reality is an electron *field* throughout the whole of space…”

First we may suggest that so conceived “multiversal object” is from the ontological point of view closer to our “normal”, macroscopic objects, since it is not just a discrete “collection” of quantum superpositions – it can be thought, at least in some sense, as a *real* object, also in the traditional ontological sense, albeit it is “dispersed” in quantum multiverse and “integrated” into an “object” only by interference among “universes”.

Next, we can state that Deutsch (2011) develops his multiverse *meta*-physics more on the concept of *decoherence,* namely in comparison with Deutsch (1997). Now, in his “story”, “multi-versal objects” become by decoherence *uni*-versal objects of our actual universe.

However, many questions remain here. Let me mention just the following: in the proposed Deutsch’s “story” it seems that, on the *one* hand, decoherence limits multiverse to a very small scale (of multiversal objects), but on the *other* hand, the whole cosmic multiverse, “baroque” with all its “Borgesian branches”, remains somewhere “out there” (this term is often used by D. himself), while we (but *who* are “we”: all of us?) follow only one, i.e. our *actual* “history”. So in this theoretical, “panoramic picture” – but observed by *whom*? – all those *doppelgängers* still remain … and the famous problem of “Schrödinger’s cat” as well!

Considering the concept of infinite or even transfinite multiverse(s) in *physical* explanations

Let us return now to Tegmark's hierarchy of multiverses and consider shortly his Level-IV, "mathematical democracy" …

The question whether *infinite* multiverses have to be introduced into "anthropic explanations" of "fine tuning" or not – is controversial (for example, Leonard Susskind needs "only" *googol* numbers, say 10^{500}, in order to picture his "megaversum", but Deutsch frequently speaks of "infinite sets of universes").

Personally, I think that, if taking the multiverse Level-IV seriously, it is unavoidable to consider not only infinite multiverses, but also the concept of *transfinite* multiverses, *per analogiam* with Cantor's transfinite sets.

Roger Penrose, in his great book *The Road to Reality* (2004), in Chapter 16 titled "The Ladder of Infinity", says:

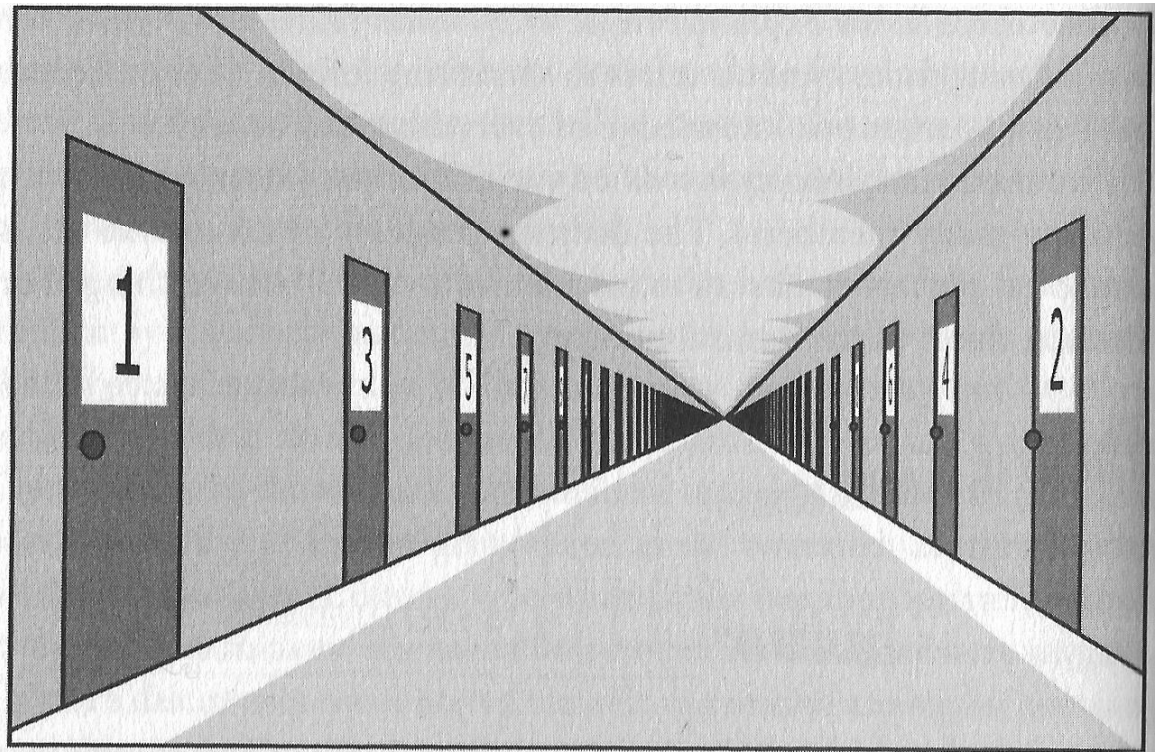
- "It is perhaps remarkable, in view of the relationship between mathematics and physics, that issues of such basic importance in mathematics as transfinite set theory and computability have as yet had a very limited impact on our description of the physical world. It is my own personal opinion that we shall find that computability issues will eventually be found to have a deep relevance to future physical theory, but only very little use of these ideas has so far been made in mathematical physics." (p. 378, underlined by M.U.)

So, let us see, what follows, if we take into account multiverse *infinities* …

Two philosophical questions concerning infinity

1) What is the relation between mathematical and physical infinity, especially in case if the general "structural isomorphism" between mathematics and physics obtains (i.e., in Tegmark's "mathematical democracy").
2) Does the metaphysical and/or theological infinity *transcend* the physical and/or mathematical infinity?

David Hilbert's
"Hotel Infinity"
(from David Deutsch's
The Beginning of Infinity, p. 168)



Problems with definition of the set *M* (= **M**ultiverse)

The role of mathematical sets in physical theories of multiverses is considered in the article "Multiverses and Cosmology: Philosophical Issues" by authors William Stoeger, George Ellis and Uli Kirchner (2006):

As they point out, in any methodologically and conceptually well-formed theory of multiverses, it is necessary –

1) first to *define* a set *M*, whose elements are all *possible* universes *m*,
2) then to determine a "distribution function" *f*(*m*), that selects within *M* actually *existent* universes,
3) and finally a criterion (also a function) that determines the *anthropic* subset among existent universes.

– but we have a heavy problem already in how to define *M*:

- "What determines *M* ? Where does this structure come from? What is the meta-cause, or ground, that delimits this set of possibilities? Why is there a uniform structure across all universes *m* in *M* ?" (Stoeger & Ellis & Kirchner 2006: 7)

Mathematical and physical infinities

There are unsolvable problems with physical ("actual") infinities:

- "When speaking of multiverses or ensembles of universes – possible or realized – the issue of infinity inevitably crops up. Researchers often envision an infinite set of universes, in which all possibilities are realized. Can there be an infinite set of really existing universes? We suggest that the answer may very well be 'No'." (Stoeger & Ellis & Kirchner 2006: 13, underlined by M.U.)

The three authors refer to David Hilbert's thought that "the presumed existence of the actually infinite directly or indirectly leads to well-recognized unsolvable contradictions in set theory" (*ibid*. 14).

- "[T]he problem with a realized infinity is not primarily physical in the usual sense – it is primarily a conceptual or philosophical problem. 'Infinity' as it is mathematically conceived […] really refers to a process rather than to an entity […] And the process it refers to has no term or completion specified. No physically meaningful parameter really possesses an infinite value." (Stoeger & Ellis & Kirchner 2006: 17, underlined by M.U.)

A digression (but just seemingly):

Immanuel Kant's cosmological antinomy of space and time

- "*Thesis*: The world has a beginning in time, and in space it is also enclosed in boundaries.
- *Antithesis*: The world has no beginning and no bounds in space, but is infinite with regard to both time and space."

(Immanuel Kant, *Critique of Pure Reason*, B454 and B455, tr. by Paul Guyer and Allen W. Wood, Cambridge U.P., 2007)

Another digression (yet very relevant for our topic):

Georg Cantor's concept of "inconsistent wholes"

Cantor presumed that some sets ("wholes") are so disproportionally large that it is impossible to assign any "power" (i.e., any cardinal number) to them, as it can be assigned to countable infinity or to continuum.

A. W. Moore stated in his book *The Infinite*: "There was [for Cantor] no such set as Ω [the "whole" of all ordinal numbers]. And this was enough to dispel the [Burali-Forti's] paradox" (Moore 1990: 127).

Cantor named such concepts "inconsistent wholes": they do not belong to the transfinite domain, but to the "domain" of *absolute* infinity, in short – to the Absolute.

Therefore, there is *no* "Cantor's paradox of the greatest Aleph".

Cantor's letter to Jourdain on July 9, 1904

- "Were we now, as Mr. Russell proposes, to replace *M* by an *inconsistent* multiplicity (perhaps by the totality of *all* transfinite ordinal numbers, which you call *W*), then a totality corresponding to *G* could *by no means be formed*. The impossibility rests upon this: an inconsistent multiplicity because it cannot be understood as a *whole*, thus as a *thing*, can*not* be used as an *element* of a multiplicity.

  Only *complete things* can be taken as *elements* of multiplicity, only *sets*, but not *inconsistent multiplicities*, in whose nature it lies, that they can never be conceived as *complete* and *actually existing*."

  (Georg Cantor, quoted from Shaugham Lavine, *Understanding the Infinite*, 1994: 99)

Cantor's transcendent conception of the Absolute

Cantor, in his early series of six treatises, titled *Ueber unendliche, lineare Punktmannichfaltigkeiten* ("About infinite, linear manifolds of points", 1879-84, the 5th is known as *Grundlagen*, 1883), wrote in the context of his critique of Aristotle's "potential infinity" the following, philosophically very significant thoughts (*Grundlagen*, § 4, note 2):

- "Plato's concept of infinity is quite different from Aristotle's […] I have found contact points for my conceptions also in the philosophy of Nicholas Cusanus. […] And I notice the same in Giordano Bruno, the follower of Cusanus. […] However, there is an essential distinction, namely that I have once for all fixed in concept the different degrees of the actual infinite with the classes of numbers (I), (II), (III) etc. […] I do not doubt that we will go on and on in this way, and that we will never encounter some impassable boundary, but that we shall also not succeed in approaching to some merely near comprehension of the Absolute. The Absolute can only be acknowledged, but never be known, it cannot be even nearly known." (Translated and underlined by M.U.)

Three levels of infinity, following Cantor

1) The “improper” (although in mathematics indispensable) infinity of addition and division, which Aristotle named “potential infinity”;
2) the “proper” (actual) infinity of transfinite numbers, ordinals and cardinals, which Cantor himself discovered; and
3) the transcendent infinity of the Absolute, which is only *symbolically* recognized in the mathematical infinity, but is never conceptually known. – “Therefore, the absolute infinite series of numbers seems to me in a certain sense as an adequate symbol of the Absolute” (Cantor, *ibid*. 116, tr. by M.U.)

Kant and Cantor, two essential similarities

Immanuel Kant
(1724-1804)

1. Cantor's conception of the absolute infinity is spiritually akin to Kant's critical philosophy. For Kant, the cosmological "totality" is a *transcendent*, dialectical "regulative idea" of the pure reason <*Vernunft*>, but it is *not* a *transcendental* ("constitutive") category of understanding <*Verstand*>.
2. Kant and Cantor share the deep comprehension that the Absolute can never be given as a whole. *The Whole* is always transcendent, and this is indeed the main lesson of Kant's antinomies: they arise, if knowledge wants to *transcend all possible experience*.

Georg Cantor
(1845-1918)

Kant's critique and modern cosmology

Like Greek classics, Kant was convinced that completeness belongs to the Whole, although the Whole, at least in science and/or in theoretical philosophy (i.e., in the domain of reason), is always slipping away from understanding – to infinity:

- "Yet the idea of this completeness still lies in reason, irrespective of the possibility or impossibility of connecting empirical concepts to it adequately" (Kant, *Critique of Pure Reason*, B 444).

In the modern cosmology, Kant's critique (in both senses, negative and positive) has to be applied to the concept of multiverse instead to the whole (or to "totality") of just *our* universe, which is yet *within* our possible experience, while the "whole *multi*verse" (whatever it means) is again the *Uni*verse which *transcends* all possible experience and therefore rises epistemo-logical antinomies.

Conclusion: **Not the world, the reason (mind) itself is whole.**

References

- Cantor, Georg (1984). *Über unendliche, lineare Punktmannigfaltigkeiten. Arbeiten zur Mengenlehre aus den Jahren 1872–1884*. Leipzig: BSB B. G. Teubner Verlagsgesellschaft.
- Deutsch, David (1997). *The Fabric of Reality*. London: Penguin Books.
- Deutsch, David (2011). *The Beginning of Infinity. Explanations that Transform the World.* New York: Viking, Penguin Books.
- Kant, Immanuel (2007). *Critique of Pure Reason*, translated and edited by Paul Guyer & Allen W. Wood. Cambridge: Cambridge University Press (13th printing).
- Lewis, David (1986). *On the Plurality of Worlds*. Oxford: Basil Blackwell.
- Penrose, Roger (2005). *The Road to Reality. A Complete Guide to the Laws of the Universe*. New York: Vintage Books.
- Tegmark, Max (2003). “The multiverse hierarchy”, reprinted in: *Universe or Multiverse?* (2007), ed. Bernard Carr, pp. 99-125. Cambridge: Cambridge University Press.
- Uršič, Marko & Markič, Olga & Ule, Andrej (2012). *Mind in Nature. From Science to Philosophy.* New York: Nova Science Publishers, Inc.