Marko Uršič
University of Ljubljana, Slovenia

Paradoxes of Transfinite Cosmology

The starting point of this paper is the question whether the modern cosmology has solved the first Kant's antinomy, i.e., whether the universe is finite or infinite in space and time. In this context, the modern concept of "multiverse" is analyzed, and some recent cosmological theories of multiverse(s) are discussed from the methodological point of the set-theory. If multiverses are conceived as sets of universes, then the concept of "Multiverse of all multiverses" yields to be paradoxical, and it seems that a return to some "meta-concept" of the Universe is unavoidable. In this sense, Cantor's "Absolute" is proposed as a possible philosophical solution of the paradoxes of infinity also for cosmological multiverses, and in the conclusion of the paper, the analogy between Cantor's Absolute, which is not a "mathematical object", and Kant's conception of the Whole of the World (in space and time etc.), which is not a constitutive category of reality, but just a "regulative idea" of transcendental dialectical thought, is proposed and discussed.

Key words: infinity, cosmology, multiverse, paradox, antinomy, Kant, Cantor.

The question of infinity vs. finiteness of the universe in space and time (or in space-time, after Einstein), which was articulated with all sharpness in Kant's first antinomy of pure reason, has not been solved yet, however, for *our* universe, i.e. for space-time which emerged from "our big-bang", it *could* be in principle answered scientifically, contrary to Kant's philosophical judgment that this question leads to an insolvable antinomy. Kant's main point concerning antinomies was that they show how pure reason transcends "all possible experience", and therefore yields just "ideas" which cannot be verified. The first antinomy is based on the idea of absolute *wholeness* of space and time, which is never given in our actual experience neither can it be given in some possible future experience. Kant was in principle right, however – and just this is argued in this paper – in modern cosmology his point has to be shifted from the universe to multiverse(s). Concerning *our* universe, we have got some important empirical facts which refer to the *whole* of it: *first*, Edwin Hubble's discovery in the 1920s of the *universal* red-shifts of spectral lines, observed in the light from all galaxies alike and dependent only of their distance (more accurately, with a few exceptions due to the local movements of some galaxies), which reveal the expansion of the universe; *second*, the *universal* distribution of matter (mostly hydrogen and helium) in all observable space; *third*, Penzias & Wilson's discovery in the 1960s of *universal* or cosmic background radiation etc. On the basis of these important empirical discoveries cosmology has become a natural *science*, in spite of Kant's conviction that this could never be the case. Furthermore, new cosmological models, based on Einstein's discovery of curved space-times and developed by Alexander Friedmann and others, have surmounted the sharpness of Kant's antinomy by showing that space-time could be finite *and* unbounded (such are, for instance, Riemann's spaces). The conjunction of finiteness and unboundedness, which reminds us of the "hermetic" statement of Nicholas Cusanus (15^{th} century) that the universe is "like the sphere which has its centre everywhere and its boundary nowhere", is impossible in Euclidean geometry with "open" topology, i.e. in the classical conception of space, which was the only "shape of space" considered by Kant as the *a priori* transcendental form of our "outer experiences".

Nevertheless, as I have said, the dilemma between finiteness vs. infiniteness of *our* universe has not been solved yet, although it might be someday. In contemporary cosmology, this dilemma is rather substituted with another formulation of the problem – which is connected with Kant's antinomy, yet not equivalent with it – expressed by the question: Is the space of our universe "open" or "closed"? For instance, the classical Euclidean space is open, Riemann's spaces are closed. Some "shape of space" is outlined by a certain cosmological model, and the adequacy of a chosen model has to be verified by empirical observations. Recent observations (of supernovas in other galaxies etc.) show that the space of our universe is probably open and that it is "flat" (i.e. that its curvature is near to the zero-value); otherwise said, the value of the density parameter $\Omega \approx 1$ means that the cosmic space is Euclidean or just slightly curved. Does it *eo ipso* mean that the space of our universe is infinite? Not necessarily, since the "openness" or "closeness" of some space is dependent not only on its geometry (curvature), but also on its topology ("deeper" shape). There are spaces which are "flat" (Euclidean, with zero curvature), but nevertheless finite or – better said – "closed"; such is, for example, the shape of space named "three-dimensional Euclidean torus": it is similar to a two-dimensional flat surface which has its edges "glued" together, so that a traveler who reaches, let us say, the left "edge" of the surface finds himself at the same moment on its right "edge", continuing his journey without any boundary (similarly as on the surface of the classical sphere, only that in the case of the Euclidean torus its surface is *flat*), and such a type of closed space has *no* edges or boundaries in spite of its finiteness.[1] An interesting, rather more sophisticated than the Euclidean 3D-torus, yet theoretically very elegant model of a closed, topologically "compact" cosmic space in the shape of slightly spherical hyper-*dodecahedron* was proposed by Jean-Pierre Luminet (see Luminet, 2008); such a "multiply connected" space implies that the objects in it (galaxies etc.) are seen by some late observer (like us) in several "replicas", which are images of the *same* object, coming from different times of its evolution; this fascinating possibility could in principle be verified, but present instruments (orbital probes etc.) are still far from being precise enough for that purpose. We may state that Luminet's model is beautiful, it has been inspired by Plato's *Timaeus*, however, its empirical verisimilitude is not very high at the moment.

If we introduce the multiverse(s) into cosmology, the scientific and philosophical answer to the classical Kantian dilemma between finiteness and infinity is shifted a large step further – in the direction of infinity, although the *actual* infinity of the multiverse is no less problematic than the actual infinity of our universe. The question whether our universe is finite or infinite, becomes additionally complicated, as John D. Barrow clearly shows us with the following hypothetical scenario: let us assume that we accept Linde's theory of "eternal inflation", in which "bubble" universes are created, among them our universe; due to random quantum fluctuations in the primary inflationary field the value of Ω in our universe (our "bubble" in the multiverse) is $\Omega \leq 1$ (or, as measurements suggest, $\Omega \approx 1$), thus our universe is – if we leave aside the possibility of some "compact topology" – *infinite* (at least potentially); but it could be the case that our "bubble" universe lies *inside* a larger "bubble", in which $\Omega > 1$ would hold, thus such a Universe, larger than our supposedly infinite universe, would be *finite*, and within it our own as well! Barrow explains: "We may think we are living in a universe of sub-critical density when we just inhabit an underdense "bubble" inside a Universe of super-critical density" (Barrow, 2005: 145). But this and similar problems with infinity in the multiverse (and of the multiverse itself) are only "symptoms", only "the peak of the iceberg", because if we thoroughly consider the *concept of the multiverse*, the concept of the cosmological "manifold", we soon notice that beside various scientific-physical problems

[1] Joseph Silk in his book *The Infinite Cosmos* says: "An important myth to overcome is the inference that a flat or even a negatively curved universe is infinite. This issue of size must be the core of cosmological tests. How can we make a hard scientific appraisal of whether the universe is infinite? It turns out that the question of whether or not the universe is nearly infinite can be experientially tested. The universe can be very large indeed, compared to the visible scale, yet its size can, in principle, be measurable" (Silk, 2006: 183).

further and deeper *methodological* problems emerge in the very conceptual apparatus of *pro et contra* discussions concerning the multiverse(s).

When Roger Penrose in Chapter 16 of *The Road to Reality*, titled "The Ladder of Infinity", discusses Cantor's transfinite set theory, he concludes that its influence on contemporary physics has been utterly small, in fact negligible in comparison to the influence of other basic mathematical disciplines (functional analysis, non-Euclidean geometries, theory of groups etc.):

> 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 (Penrose, 2005: 378).

It is rather striking that almost none of the physical theories seems to need to go beyond the cardinality of the real-number system, states Penrose. This statement certainly holds for the application of the *results* of transfinite set theory, but it is less justified regarding the *type of thinking* itself, i.e. regarding the conceptual apparatus (also the concealed one) employed in some extreme, highly "speculative" physical theories, which in particular holds for the theories of the multiverse; yet, it is true that the main protagonists of the theories of multiverses (Leonard Susskind, Andrei Linde, Martin Rees *et al.*), who are eminent physicists and/or cosmologists, have so far not concerned themselves much with the conceptual, "meta-theoretical" grounds of their theories. It is mainly critics who engage in this, but gradually more distinctive logical-analytic approaches have established themselves on "both sides" in debates about the multiverse, which we can notice also in the referential collection of essays *Universe or Multiverse?* (2007), edited by Bernard Carr (especially in the papers by George Ellis, Anthony Aguirre and Lee Smolin). There is neither a unanimous nor a uniform answer to the question whether the physical multiverse requires an *infinite* set of universes or not,[2] however, we may state that some kind of *transfinite cosmology* in analogy to Cantor's transfinite set theory is gradually emerging, because in more analytical approaches universes figure as elements of the multiverse set (or "manifold"), which in principle allows for iteration, namely for multiverses as elements of the Multiverse of the second order and so on … *ad infinitum*? The question correlative to this one is the question about physical laws, which vary in the universes, sets of "effective by-laws" becoming thus elements of the set of Laws of the second order (laws of laws or "meta-laws") – and it seems that this iteration cannot avoid falling into *regressus ad infinitum*.

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. They rightly state in the introduction that for an "anthropic explanation" of the "fine tuning" of our universe some just *possible* multiverse does not suffice, since we need "universes which *actually* exist, along with mechanisms which generate their existence" (S. & E. & K. 2006: 4; italics by M.U.); thus, it is necessary first to *define* a set M, whose elements are all *possible* universes m, then to determine a "distribution function" $f(m)$, that selects within M actually *existent* universes, and finally a criterion (also a

[2] Leonard Susskind gives the megagugol number ~10^{500} of possible universes, that is, "inhabitable valleys" (or local *vacua*) in the virtual "Cosmic Landscape", derived from string theory. This number expresses the "lower limit" of different Calabi-Yau spaces in ten dimensions, geometrical and topological forms of "compact" (hidden, "curled") hyper-dimensions which determine the characteristics of strings and with this also the values of physical parameters in the "normal" three dimensions. Susskind adopts the number ~10^{500} by R. Bousso & J. Polchinski, who named such kind of number "discretum" or "practical continuum".

function) that determines the *anthropic* subset among existent universes. But we get stuck already by the question of 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)

Because if M really encompasses all the possibilities of universes, we have to know how to decide *which* are "all" the possibilities or where are the *limits* of these possibilities, but "these questions cannot be answered scientifically, though scientific input is necessary for doing so. How can we answer them philosophically?" (*ibid*.). This first difficulty is followed by others, from the question of how to define the function $f(m)$ to the question of how to conceive of the *anthropos* in "anthropic explanations". The three authors especially warn about problems with infinity:

> 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).

Beside some general methodological reasons against an infinite multiverse irresolvable problems crop up when we try to carry some well defined concepts of infinity from mathematics, where they have formed in a long and careful development of formal systems (*cf*. in the Zermelo-Fraenkl axiomatic set theory), to the field of physics, that is, to transform *mathematical* infinity into *physical* infinity. The three authors quote 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). We are dealing, of course, with the famous Russell's paradox of "the set of all sets which do not contain themselves" and its variants, especially the Burali-Forti paradox of "the highest ordinal number". This kind of "syntactical paradoxes", as Russell named them, are not solvable directly, but they can be avoided with a careful selection of mathematical axioms, definitions etc. However, if we apply Cantor's "real" (actual) infinity of transfinite numbers to *physical* models of multiverses as infinite sets of universes, we do not have any possibility of "control" over the selection of the axioms, because "boundary conditions" are determined by physical reality, cosmological laws, they are not "free mathematical constructions" (in Cantor's sense), which are limited only by logical consistency. For instance, Russell's "axiom of infinity" cannot simply be carried over to physics and cosmology.

The paradoxes of set theory point to the problem that emerges if we put some "existent" (in the mathematical sense: non-contradictory, at least seemingly) entity on the top of the hierarchical pyramid, for example in the Burali-Forti paradox the *largest* ordinal number, that is, the ordinal number of *all* ordinal numbers. But *analogue* paradoxes appear in physical models of multiverses if we allow for their boundless ascent "upwards" to the supposedly "highest" Multiverse. That is, with which arguments should we reject the existence of this cosmological "maximum" if the very "logic" of construction of multiverses (the variation of physical parameters, laws, dimensions, topologies etc.) leads to this "real" but unavoidably paradoxical Entity? If we want to stay *within science*, we have to define this supposedly "highest" Multiverse with some Laws, but in doing so we cannot leave out of account some even higher Laws, which sanction those Laws "below" them … and so we get caught into a cosmological variant of the Burali-Forti (and/or Russell's) paradox. The only way to re-solve this paradox is a "breakthrough" to some other "sphere" of meaning which *transcends* scientific, physical cosmology. It is useful to reconsider how Cantor himself looked on the paradoxes of set theory, disclosed by Russell and others. Why didn't they move him so much as they did Russell and especially Frege? The answer is simple and instructive: because Cantor in his "highest" mathematical thoughts *transcended* mathematics! Let us have a look at how this is possible.

A. W. Moore in his book *The Infinite* conjectures that Cantor was not concerned with the Burali-Forti paradox (and similar "syntactic" paradoxes of set theory) because in constructing transfinite mathematics he presumed that some sets ("wholes") are so disproportionally large that it is impossible to assign any "power" to them (i.e., any cardinal number), as we can assign, for example, to countable infinity ($\aleph_0$) or to the continuum ($\aleph_1$). Such an example is the "whole" of all ordinal numbers: "There was no such set as Ω. And this was enough to dispel the paradox" (Moore, 1990: 127). Cantor named such concepts "inconsistent wholes" that do not belong to the transfinite domain but to the "domain" of *absolute* infinity, or in short – to the Absolute. Something analogous holds for "the set of *all* sets" (with Russell's predicate "that do not contain themselves" or without it): Cantor did not accept such inconsistent wholes in his transfinite arithmetic, and that is why there is no "Cantor's paradox" of the largest cardinal number. We can, of course, object this, especially if we follow Russell's diagnosis of the problems with infinity in mathematics and/or logic and if we accept his "theory of logical types", a very radical therapy for paradoxes. However, this is not the only possible and maybe even not the only correct view of the "paradoxes of set theory".

Shaughan Lavine in his monograph *Understanding the Infinite*, in which the main topic is the analysis of Cantor's transfinite mathematics and its "natural" continuation in the Zermelo-Frankl axiomatic system, observes that – *contrary* to philosophers of mathematics like Frege and Russell and others who followed them – Cantor *did not* accept the Peano-Russell's "Comprehension Principle", which says that "a class may be defined as all the terms satisfying some propositional function" (Lavine, 1994: 63); that is, such a "logistic", functional definition of a class or set unavoidably leads, according to Lavine, to paradoxes (see *ibid*., 66) while Cantor's presumably "naïve" definition of a set avoided them because he – as Lavine says – determined a set as a "combinatorial collection", "defined by the enumeration of its terms" (*ibid*., 77). Combinatorial collections are "more general than [Russell's] logical collections" (*ibid*.), and at the same time such a definition of a set is more restrictive: "Since combinatorial collections are enumerated, some multiplicities may be too large to be gathered into a combinatorial collection" (*ibid*., 78).[3] The way how Cantor avoided Russell's paradox might be seen also from his letter to Jourdain on July 9, 1904:

> Were we now, as Mr. Russell proposes, to replace $\mathfrak{M}$ by an *inconsistent* multiplicity (perhaps by the totality of *all* transfinite ordinal numbers, which you call $\mathfrak{W}$), then a totality corresponding to $\mathfrak{G}$ 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

[3] William W. Tait in his article "Cantor's *Grundlagen* and the Paradoxes of Set Theory" expresses a rather different view from Lavine, by arguing that the Comprehension Principle ("every property determines a set") became problematic only after having been applied to transfinite numbers: "With the introduction of transfinite numbers, though, Cantor immediately recognized that the notion of set was problematic, to the extent of understanding that not *every* property of numbers 'unites the objects possessing it into a whole', thereby determining a set. So […] he was not naïve. […] But Pandora's Box is indeed open: Under what conditions *should* we admit the extension of a property of transfinite numbers to be a set – or, equivalently, what transfinite numbers are there" (Tait, 2000: 284). In some other passage of this paper, Tait points out that Cantor distinguished between the "determinate infinities" and the "absolute infinite" (*ibid*., 275), and just *this* distinction is essential for our present context.

nature it lies, that they can never be conceived as *complete* and *actually existing* (Cantor, in Lavine, 1994: 99).

It is indeed interesting and inspiring to read how Cantor, the discoverer of transfinite numbers, writes about the conceptual "completion", which was, classically understood, the very opposite of infinity. Following Cantor, Lavine advocates a kind of moderate variant of mathematical constructivism, which contrary to Brouwer's radical intuitionism accepts transfinite sets, but subtly "enumerated" in the ZF-axioms. We philosophers have to leave the final judgment about whether Lavine's interpretation of Cantor against Russell is correct to mathematicians or historians of mathematics. For philosophers it is Cantor's attitude toward the Absolute that is interesting, since it enables him to overcome paradoxes. In the context of his critique of Aristotle's concept of just potential infinity, Cantor wrote in his important treatise *Ueber unendliche, lineare Punktmannichfaltigkeiten* ("About infinite, linear manifolds of points", Part 5 [1883], § 4, note 2) the following, very significant thoughts:

> Die Auffassung Platons vom Unendlichen ist eine ganz andere, wie die des Aristoteles […] Ebenso finde ich für meine Auffassungen Berührungspunkte in der Philosophie des Nicolaus Cusanus. […] Dasselbe bemerke ich in Beziehung auf Giordano Bruno, den Nachfolger des Cusaners. […] Ein wesentlichen Unterschied besteht aber darin, dass ich die verschiedenen Abstufungen des Eigentlich-unendlichen durch die Zahlenclassen (I), (II), (III) u.s.w. ein für allemal dem Begriffe nach fixire und es erst nun als Aufgabe betrachte, die Beziehungen der überendlichen Zahlen nicht nur mathematisch zu untersuchen, sondern auch allüberall, wo sie in der Natur vorkommen, nachzuweisen und zu verfolgen. Dass wir auf dieser Wege immer weiter, niemals an eine unübersteigbare Grenze, aber auch zu keinem auch nur angenäherten Erfassen des Absoluten gelangen werden, unterliegt für mich keinem Zweifel. Das Absolute kann nur anerkannt, aber nie erkannt, auch nicht annähernd erkannt werden (Cantor, 1984: 115).[4]

Cantor refers to Plato with the *transcendence* of the Absolute, to Cusanus with his *symbolic* "recognizing" of the Absolute, to Bruno with his actual *infinity* in the *One*, which, following the Neo-Platonic tradition, "encompasses" by the cosmic Mind all worlds, albeit they are infinitely many. He expresses the symbolic meaning of mathematical infinity in the continuation of the quoted passage: "Die absolute unendliche Zahlenfolge erscheint mir daher in gewissem Sinne als ein geeigneten Symbol des Absoluten" (*ibid*., 116).[5] – Cantor thus discerns *three* levels of infinity: 1. "improper" (although in mathematics indispensable) infinity of "addition" and "division", which Aristotle named potential infinity; 2. "proper" (actual) infinity of transfinite numbers, ordinals and cardinals, which he himself discovered; and 3. transcendent infinity of the Absolute, which is only symbolically recognized in mathematical infinity, but is never conceptually known.[6]

[4] "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, that is, 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. [later Cantor named them "cardinal numbers"], and only then have I considered the task to research the infinite numbers not only mathematically, but also to track them generally and demonstrate where they occur in nature. 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 some merely near comprehension of the Absolute. The Absolute can be only acknowledged, but never get known, it cannot be even nearly known." (Translated by M. U.)

[5] "Therefore, the absolute infinite series of numbers seems to me in a certain sense an adequate symbol of the Absolute." (Translated by M. U.)

[6] John Barrow calls our attention to the vicinity of Cantor's conception of the Absolute with Anselm's conception of God when he says: "Thus Cantor seems to think of Absolute Infinity in the way that Archbishop

Cantor’s conception of absolute infinity is spiritually akin to Kant’s philosophy, in spite of the fact that Cantor did not like Kant’s philosophy, at least following his letter to Russell in 1911.[7] For Kant, (meta)physical infinity is a *regulative idea* of pure reason <*Vernunft*>, but it is *not* an object-constituting transcendental category of understanding <*Verstand*>. If Kant had been alive to witness Cantor’s discovery of “real” (actual) mathematical infinities, he would have probably been surprised, but this would not shake the foundations of his critical philosophy, maybe it would have had an even lesser influence on it than the discovery of non-Euclidean geometries had on Neo-Kantianism, especially on Ernst Cassirer. What deeply links Kant and Cantor is the apprehension that the Absolute can never be given as a *whole*. The whole is always transcendent, also in cosmology, and this is the main lesson of Kant’s antinomies, especially of the first one that stems out of the transcendental category of wholeness (or totality) – the antinomy arises if knowledge wants to transcend all possible experience of space and time. The concepts of space and time themselves are not antinomic, because we are always *within* some sequence of ever larger spaces and times, but the “whole” of space as well as time is not given to us *outside* these finite spaces and times, it is not given even within any “possible experience” – that is why it is, according to Kant, meaningless to ask about the “whole” of space and time, i.e., about whether this “whole” is finite or infinite. In Chapter 7 of the cosmological antithetic under the title “Critical Solution of the Cosmological Problem” Kant says that if we take away the “transcendental illusion” that the world is “a thing in itself, then the contradictory conflict of the two assertions is transformed into a merely dialectical conflict, and because the world does not exist at all (independently of the regressive series of my representations), it exists neither as *an in itself infinite* whole nor as *an in itself finite* whole” (Kant, 2007: 518 [B 532-33]).

If the concept of the *whole* or the category of “totality”, which is one of the twelve pure concepts of understanding <*Verstand*> in Kant’s transcendental analytic, transcends all possible experience – like in assertions concerning the *universe* “as a whole” – then it becomes a *dialectic idea* of pure reason <*Vernunft*>, which does not refer to any objectivity *per se* since an idea cannot constitute any “thing in itself”, although it is necessary for understanding as a *regulative* idea, that is as a limit or measure of a whole “series of appearances”; otherwise said, the conceptual, rational understanding of the world of phenomena (in this case of their quantity) needs the regulative epistemic “openness” of the whole series. So the main point of Kant’s first cosmological antinomy is the following: regarding the *idea of the whole*, we cannot say neither that the world is finite nor that it is infinite. And like by the classics, for Kant it also holds that *completeness* lies only in the *whole*, although it is slipping away from understanding into 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, 2007: 465 [B 444]). Kant’s thought that the world does *not* exist as a *thing* in itself, or more properly said, that the “world as whole” is not an experienceable whole, nowadays still holds, *if* by world we mean “everything there is”: the Universe or Cosmos in the maximal sense. That is, from the point of view of contemporary

---

Anselm thought of God in his famous ‘ontological’ proof of the existence of God, as being that above which no greater could be conceived” (Barrow, 2005: 89).

[7] Cantor wrote to Russell on September 19, 1911, *inter alia*, these harsh words: “… and I am *quite an adversary of Old Kant*, who, in my eyes has done much harm and mischief to philosophy, even to mankind; as you easily see by the most perverted development of metaphysics in Germany in all that followed him, as in Fichte, Schelling, Hegel, Herbart, Schopenhauer, Hartmann, Nietzsche, etc. etc. on to this very day. I never could understand that and why such reasonable and ennobled people as the Italians, the English and the French are, could follow that yonder *sophistical philistine*, who was *so bad a mathematician*.” (I am indebted for this quotation to Jari Palomäki in Nancy, 2011.)

cosmology the Universe is not only "our universe" – which is yet, according to the standard "big-bang" cosmology, a "relative" whole, it is the largest "thing" *within* our possible experience – but it is the *multiverse* that has today become the transcendent and in principle unreachable *whole* in the Kantian sense. Contemporary scientific cosmology talks much about the multiverse(s), but a critical philosophical thought recognizes in the "whole" of the Multiverse once again the transcendent *Universe*.

To sum up: in this paper I have tried to show, *first*, that contemporary theories of multiverses transcend not only available physical experience, but tend to slip also beyond all possible human experience, and that is why the Kantian critique of "cosmological ideas" is still justified and relevant, although many specific elements of Kant's own critique have to be changed, "updated" (due to Non-Euclidean geometries, the theory of relativity, Hubble's discovery of universal red-shifts, etc.); and *secondly*, in respect of a possible (and as it seems also reasonable) use of the conceptual apparatus of mathematical set theory in the analysis of the theories of multiverses, an important epistemological question, analogous with Russell's question to the "naïve" set theory, is raised and has to be answered, namely concerning the infinite *regressus* in these theories. The problem of paradoxes of the presumably "highest" Multiverse (i.e. the "multiverse of all multiverses") has to be solved at least "in principle" – and in this respect it is worth to call into attention Cantor's belief in the transcendence of the Absolute, which transcends all its "symbolic" manifestations in transfinite numbers. Cantor himself was a Christian believer, a catholic, but his conception of the transcendence of the infinite Absolute is theoretically independent of his personal religious belief. So we may in our context, *per analogiam*, address with Cantor's "lesson" to Russell (and to other "logicists") those contemporary physicists and/or cosmologists who – sometimes too "naively" – advocate multiverses: *beyond* all multiverses, at least as a transcendent "regulative idea", there is still the Universe, the Absolute. Without this idea of the ultimate *whole(ness)* no consistent thought about multiverses would be possible, since if we "multiply" our universe in such a way as to place it among a multitude of other universes, i.e., if we introduce the *concept* of multiverse(s), the question of the ultimate Unity nevertheless remains, and my answer to this question (following Kant, Cantor and other great minds) is that the "highest" Multiverse is indeed *the Universe*, which cannot be reached by scientific theories, since it is not an empirical phenomenon among or next to other phenomena – the Universe can be apprehended only by "pure reason", and it might be "experienced" by a mystical insight in the sense of Ludwig Wittgenstein: *Whereof one cannot speak, thereof one must be silent.*

References

Barrow, John D. (2005). *The Infinite Book*. London: Vintage.

Cantor, Georg (1984). *Über unendliche, lineare Punktmannigfaltigkeiten. Arbeiten zur Mengenlehre aus den Jahren 1872–1884*. Leipzig: BSB B. G. Teubner Verlagsgesellschaft.

Carr, Bernard, ed. (2007). *Universe or Multiverse?* Cambridge: Cambridge University Press.

Kant, Immanuel (2007). *Critique of Pure Reason*, translated and edited by Paul Guyer & Allen W. Wood. Cambridge: Cambridge University Press (13^{th} printing).

Lavine, Shaugham (1994). *Understanding the Infinite*. Cambridge/MA & London: Harvard University Press.

Luminet, Jean-Pierre (2008). *The Wraparound Universe*. Wellesley, Massachusetts: A K Peters.

Moore, A. W. (1990). *The Infinite*. London: Routledge.

Penrose, Roger (2005). *The Road to Reality. A Complete Guide to the Laws of the Universe*. New York: Vintage Books.

Silk, Joseph (2006). *The Infinite Cosmos*. Oxford: Oxford University Press.

Stoeger, William R. & Ellis, George F. R. & Kirchner, Uli (2006). “Multiverses and cosmology: philosophical issues”, on the web side arXiv:astro-ph/0407329v2.

Susskind, Leonard (2006). *The Cosmic Landscape. String Theory and the Illusion of Intelligent Design*. New York: Back Bay Books, Little, Brown & comp.

Tait, William W. (2000). “Cantor’s *Grundlagen* and the Paradoxes of Set Theory”, in: *Between Logic and Intuition: Essays in Honor of Charles Parsons* (eds. G. Sher & R. Tieszen), pp. 269–290. Cambridge: Cambridge University Press.

Uršič, Marko & Markič, Olga & Ule, Andrej (2012). *Mind in Nature* (World Philosophy Series). New York: Nova Science Publishers, Inc.