Oliver Passon · Christoph Benzmüller · Brigitte Falkenburg *Hrsg.*

On Gödel and the Nonexistence of Time – Gödel und die Nichtexistenz der Zeit

Kurt Gödel essay competition 2021 – Kurt-Gödel-Preis 2021

Springer Spektrum

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Preface

In 2021, René Talbot and Hans Schwarzlow from the *Kurt Gödel Freundeskreis* (*Kurt Gödel circle of friends*) in Berlin announced the second edition of the Essay competition for the Kurt Gödel Award.[1] The prize was endowed with 15.000 EUR and awarded with assistance of the University of Wuppertal (Germany). This time, the prize question was "What does it mean for our world view if, according to Gödel, we assume the nonexistence of time?"

Famously, Kurt Gödel was not just a brilliant logician and mathematician but also contributed important results to the general theory of relativity. In the 1940s, he found a solution to Einstein's field equations that allows for so-called "closed time-like curves". However, what does this mean in everyday language? Vividly explained, Gödel found a universe in which it is possible to time travel! Now, travelling through time—in particular into one's own past—certainly compromises our very notion of time in the first place. Gödel suggested, therefore, that already the theoretical possibility of such a universe questions the existence of time.[2] All this is the background to the prize question on the implications of such a nonexistence of time for our world view.

A multidisciplinary jury, consisting of Brigitte Falkenburg, Christoph Benzmüller and Oliver Passon had to sift the anonymised submissions and finally decided to award the first prize to logician and philosopher Reinhard Kahle from the University of Tübingen (Germany) for his essay entitled "The Philosophical Meaning of the Gödel Universe" (Chap. 3). The second prize was shared among five contributions, which span a wide range of approaches towards this issue. This is also reflected in the authors' diverse professional backgrounds in philosophy (Michał Pawłowski and Bartosz Wesół), physics (Claus Kiefer), theology (Thorben Alles) or computer science (Tim Lethen). This, in case readers are wondering, is also the order of the contributions in the book.

However, Kahle's contribution did what good philosophy is supposed to do: It immediately triggered a controversy. The recognised philosopher and Gödel

[1] See https://kurtgoedel.de for further details and information on the previous edition of the prize in 2019.

[2] In addition, Gödel's solution describes a *rotating* universe. This is also relevant to the issue of time; see, e.g. Chap. 2.

scholar Palle Yourgrau (Brandeis University) took umbrage at some of Kahle's arguments, and thus we invited him to contribute a reply to Kahle's paper, in which he elaborates in particular Gödel's temporal idealism (see Chap. 5). Reinhard Kahle feels honoured that Prof. Yourgrau took the time to discuss his contribution in this article. In his opinion, the philosophical differences might be much fewer than it seems, as Kahle does not intend to questions Gödel's temporal idealism, but rather the role of the Gödel universe for this position. He will reply in more detail at some other occasion. He would only like to point out that two of the issues raised are based on ambiguities in the translation of the original paper, which should have been clarified earlier (see Footnotes 10 and 19 in Chap. 5).

Moreover, there is more material that we would like to provide for a proper contextualisation of the essays. In order to keep the volume self-contained we decided to reprint the Gödel essay *Remark About the Relationship Between Relativity Theory and Idealistic Philosophy* from 1949 (Chap. 1). Furthermore we have included some relevant material of the chapter "Time Travel and Time Machines" by Chris Smeenk and Christian Wüthrich (originally published in 2011 in *The Oxford Handbook of Philosophy of Time*, Craig Callender (Ed.) Oxford University Press) to provide some technical background (Chap. 2).

Finally, another editorial decision concerned the language of publication. The essay competition invited contributions in English and in German. We decided to translate the German contributions to achieve a book for an international readership (while at the same time including the German versions; this concerns the essays from Kahle, Kiefer and Alles). However, there is one exception here. Guido Stemme's contribution to the essay competition has a special artistic touch to it, which renders a proper translation challenging. While we did not award a prize to this essay, we decided to enrich the present publication by including it in the original (i.e. German) version (Chap. 13).

On the whole, we hope to have achieved an enjoyable and thought-provoking text that provides a multi-faceted approach to a perennial issue: time.

Wuppertal & Berlin
Dezember 2022

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Oliver Passon is a private lecturer in physics education at the University of a Wuppertal (Germany). He has studied physics, mathematics, educational science and philosophy in Wuppertal and obtained his PhD in Particle Physics. His areas of work and interest cover physics education of quantum theory, history and philosophy of science, phenomenological optics and Goethe's theory of colour. Together with Tim Lethen he has edited Kurt Gödel's notebooks on quantum mechanics (*Kurt Gödels Notizen zur Quantenmechanik*, Springer 2021). Other recent publications include (together with C. Friebe et al.) *The Philosophy of Quantum Physics* (Springer, 2018) and (together with C. Benzmüller) *Wider den Reduktionismus* (Springer 2021).

Christoph Benzmüller is Professor of AI Systems Engineering at the University of Bamberg. As an Adjunct Professor (apl.); he is also affiliated with the Department of Mathematics and Computer Science at Freie Universität Berlin (where he was the first UNA-Europe Visiting Professor) and he maintains a close research collaboration with the University of Luxembourg. In addition, he advises AI startup companies in Germany and abroad. Benzmüller's research addresses topics such as the automation of rational argumentation and normative reasoning (e.g. to control intelligent systems), universal logic and universal reasoning, computational metaphysics and the mechanization of foundational theories in mathematics and philosophy. Benzmüller has conducted research as a Visiting Professor/Research Fellow at numerous prestigious universities, including Stanford University (USA), Cambridge University (UK) and Carnegie Mellon University (USA).

Brigitte Falkenburg is Professor of Philosophy (retired) in the Department of Philosophy and Political Science at the Technische Universität Dortmund. She holds a diploma in physics, a PhD in Philosophy and a second PhD in Physics. Her areas of specialization are philosophy of science (philosophy of physics, philosophy of neuroscience), history of philosophy (Kant, Hegel, neo-Kantianism), philosophy of technology. She is a member of the *Académie Internationale de Philosophie des Sciences*. Selected publications as author or editor include *Kant's Cosmology* (Springer 2020), *Mechanistic Explanations in Physics and Beyond* (Springer 2019,

with Gregor Schiemann), *Why More Is Different* (Springer 2015, with Margaret Morrison), *From Ultrarays to Astroparticles* (Springer 2012, with Wolfgang Rhode) and *Mythos Determinismus: Wieviel erklärt uns die Hirnforschung?* (Springer 2012).

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Teil I
Historical and technical context

1 Remark About the Relationship Between Relativity Theory and Idealistic Philosophy

Kurt Gödel

One of the most interesting aspects of relativity theory for the philosophically minded consists in the fact that it gave new and surprising insights into the nature of time, of that mysterious and seemingly self-contradictory[1] being, which, on the other hand, seems to form the basis of the world's and our own existence. The very starting point

[1] Cf., e.g. J.M.E. McTaggart, "The Unreality of Time". Mind, 17, 1908.

[2] At least if it is required that any two point events are either simultaneous or one succeeds the other, i.e. that temporal succession defines a complete linear ordering of all point events. There exists an absolute partial ordering.

Reprinted with kind permission of the *Shelby White and Leon Levy Archives Center* of the *Institute for Advanced Study* from *Kurt Gödel: Collected Works*: Volume II (Publications 1938–1974). Edited by Solomon Feferman, John W. Dawson, Jr., Stephen C. Kleene, Gregory H. Moore, Robert M. Solovay, and Jean van Heijenoort (1990, pp. 202–207).
This work was first published in 1949 for a collection intended to honour and discuss Einstein's work (Schilpp, P. A. (Ed.) *The Library of Living Philosophers, Volume 7. Albert Einstein: Philosopher-Scientist.* Open Court 1949, pp. 557–562). For the German edition (Eine Bemerkung über die Beziehungen zwischen der Relativitätstheorie und der idealistischen Philosophie. In: *Albert Einstein als Naturforscher und Philosoph,* P.A. Schilpp (Ed.) Kohlhammer 1955, pp. 406–412) Gödel added two remarks in the footnotes. The present version follows the original text of 1949 but includes these additions from the German version in translation. Note that these additions apparently make some difference – Kahle's contribution (Sect. 3 and 4) refers to them.

Kurt Gödel ist verstorben.

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New Jersey, USA

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of special relativity theory consists in the discovery of a new and very astonishing property of time, namely the relativity of simultaneity, which to a large extent implies[2] that of succession. The assertion that the events A and B are simultaneous (and, for a large class of pairs of events, also the assertion that A happened before B) loses its objective meaning, in so far as another observer, with the same claim to correctness, can assert that A and B are not simultaneous (or that B happened before A).

Following up the consequences of this strange state of affairs, one is led to conclusions about the nature of time, which are very far reaching indeed. In short, it seems that one obtains an unequivocal proof for the view of those philosophers who, like Parmenides, Kant, and the modern idealists, deny the objectivity of change and consider change as an illusion or an appearance due to our special mode of perception.[3] The argument runs as follows. Change becomes possible only through the lapse of time. The existence of an objective lapse of time,[4] however, means (or, at least, is equivalent to the fact) that reality consists of an infinity of layers of "now", which come into existence successively. However, if simultaneity is something relative in the sense just explained, reality cannot be split up into such layers in an objectively determined way. Each observer has his own set of "nows", and none of these various systems of layers can claim the prerogative of representing the objective lapse of time.[5]

[3] Kant, in the Critique of pure reason, 2nd ed. (1787, p. 54), expresses this view in the following words: "Those affections which we represent to ourselves as changes, in beings with other forms of cognition, would give rise to a perception in which the idea of time, and therefore also of change, would not occur at all". This formulation agrees so well with the situation subsisting in relativity theory that one is almost tempted to add: such as, e.g. a perception of the inclination relative to each other of the world lines of matter in Minkowski space.

[4] One may take the standpoint that the idea of an objective lapse of time (whose essence is that only the present really exists) is meaningless. This is no way out of the dilemma; for by this very opinion, one would take the idealistic viewpoint as to the idea of change, exactly as those philosophers who consider it as self-contradictory. For in both views one denies that an objective lapse of time is a possible state of affairs, a fortiori, that it exists in reality, and it makes very little difference in this context, whether our idea of it is regarded as meaningless or as self-contradictory. Of course, for those who take either one of these two viewpoints the argument from relativity theory given below is unnecessary, but even for them it should be of interest that perhaps there exists a second proof for the unreality of change based on entirely different grounds, especially in view of the fact that the assertion to be proved runs so completely counter to common sense. A particularly clear discussion of the subject independent of relativity theory is to be found in Paul Mongré, Das Chaos in kosmischer Auslese, 1898.

[5] It may be objected that this argument only shows that the lapse of time is something relative, which does not exclude that it is something objective, whereas idealists maintain that it is something merely imagined. A relative lapse of time, however, if any meaning at all can be given to this phrase, would certainly be something entirely different from the lapse of time in the ordinary sense, which means a change in the existing. The concept of existence, however, cannot be relativized without destroying its meaning completely. It may furthermore be objected that the argument under consideration only shows that time lapses in different ways for different observers, whereas the lapse of time itself may nevertheless be an intrinsic (absolute) property of time or of reality. A lapse of time, however, which is not a lapse in some definite way seems to me as absurd as a coloured object that has

This inference has been pointed out by some, although by surprisingly few, philosophical writers, but it has not remained unchallenged. Actually to the argument in the form just presented it can be objected that the complete equivalence of all observers moving with different (but uniform) velocities, which is the essential point in it, subsists only in the abstract space-time scheme of special relativity theory and in certain empty worlds of general relativity theory. The existence of matter, however, as well as the particular kind of curvature of space-time produced by it, largely destroys the equivalence of different observers[6] and distinguishes some of them conspicuously from the rest, namely, those that follow in their motion the mean motion of matter.[7] Now in all cosmological solutions of the gravitational equations (i.e. in all possible universes) known at present the local times of all these observers fit together into one world time, so that apparently it becomes possible to consider this time as the "true" one, which lapses objectively, whereas the discrepancies of the measuring results of other observers from this time may be conceived as due to the influence that a motion relative to the mean state of motion of matter has on the measuring processes and physical processes in general.

From this state of affairs, in view of the fact that some of the known cosmological solutions seem to represent our world correctly. James Jeans has concluded[8] that there is no reason to abandon the intuitive idea of an absolute time lapsing objectively. I do not think that the situation justifies this conclusion and am basing my opinion chiefly[9] on the following facts and considerations:

no definite colours. However, even if such a thing were conceivable, it would again be something totally different from the intuitive idea of the lapse of time to which the idealistic assertion refers.

[6]Of course, according to relativity theory all observers are equivalent in so far as the laws of motion and interaction for matter and field are the same for all of them. However, this does not exclude that the structure of the world (i.e. the actual arrangement of matter, motion, and field) may offer quite different aspects to different observers, and that it may offer a more "natural" aspect to some of them and a distorted one to others. The observer, incidentally, plays no essential role in these considerations. The main point, of course, is that the [four-dimensional] world itself has certain distinguished directions, which directly define certain distinguished local times.

[7]The value of the mean motion of matter may depend essentially on the size of the regions over which the mean is taken. What may be called the "true mean motion" is obtained by taking regions so large that a further increase in their size does not any longer change essentially the value obtained. In our world, this is the case for regions including many galactic systems. Of course, a true mean motion in this sense need not necessarily exist.

[8]Cf. *Man and the Universe,* Sir Halley Stewart Lecture (1935), 22–23.

[9]Another circumstance invalidating Jeans' argument is that the procedure described above gives only an approximate definition of an absolute time. No doubt, it is possible to refine the procedure so as to obtain a precise definition, but perhaps only by introducing more or less arbitrary elements (such as, e.g. the size of the regions or the weight function to be used in the computation of the mean motion of matter). It is doubtful whether there exists a precise definition that has so great merits that there would be sufficient reason to consider exactly the time thus obtained as the true one.