Gödel, the Unreality of Time and Mathematical Platonism

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1. Introduction

This work aims to highlight a correlation between Gödel's mathematical Platonism and unreality of time in Gödel's philosophical perspective. To do that, I will take into account Gödel's rotating universe, which is a mathematical solution of Einstein's field equations of gravitation. Indeed, Gödel's rotating universe backs the idea that absolute time that is valid throughout the universe and not subjective, does not exist. This is demonstrated by Gödel offering a peculiar temporal dimension where time could be both linear and circular. In this paper, I will consider all the above mentioned aspects and I will read them in connection with Gödel's mathematical Platonism. According to this line of thought, mathematical entities exist in an abstract dimension and mathematical truths are discovered. Thus, I will highlight that Gödel's rotating universe could exist in an abstract dimension if one commits to mathematical Platonism, even though our physical laws demonstrate that it does not exist in the actual world. In other words, I will underline that according to Gödel's philosophical perspective, he has likely assumed to have discovered a new existent abstract universe. Therefore, in line with what I mentioned above, the unreality of time is confirmed both by physics and mathematics for Gödel. This because, there exists at least another temporal dimension, as the rotating universe shows, where time "flows" in a different way.

In this article, I will firstly consider McTaggart's perspective on the unreality of time since McTaggart's theory has been a guiding one for Gödel. Moreover, McTaggart's perspective is able to highlight that time, as we generally understand it, is contradictory. Secondly, I will examine the unreality of time from a physical perspective detailing the Twin Paradox, in which the existence of absolute time is refuted. After that, I will take into account Gödel's rotating universe. Finally, I will consider mathematical Platonism, which is shared by Gödel and supports Gödel's viewpoint on the non-existence of time.

2. McTaggarts' unreality of time

McTaggart's major work on time is *The Unreality of Time*, written in 1908. As the title of the abovementioned work shows, McTaggart's main purpose is to demonstrate that time is unreal. Indeed, McTaggart's main concern is to give unassailable arguments in favour of the non-existence of time and he starts by distinguishing two kinds of temporal classifications: the first one is made of past/present/future while the second one consists of before/after. McTaggart explains that the abovementioned classifications are two temporal series. The first series is called A-series while the second one is the B-series.

The relations of the B-series are permanent, given the fact that if we consider a series of events *m*, *n*, *o,* event *n* will have perpetually occurred prior to event *o* and after event *m*. On the contrary, A series implies mutation. Indeed, we all know that each event is initially located in the future, after that it becomes present and finally joins the past dimension. McTaggart also specifies that:

> the distinction of past, present and future is as *essential* to time as the distinction of earlier and later, while in a certain sense, as we shall see, it may be regarded as more *fundamental* than the distinction of earlier and later. And it is because the distinctions of past, present and future seem to me to be essential for time, that I regard time as unreal.[1]

In other words, McTaggart grounds his argument on the assumption that being A-series more fundamental to time, the non-existence of A-series straightforwardly takes to the non-existence of time. To demonstrate the first issue, i.e. that the A-series is more fundamental than the B-series, McTaggart clarifies that B-series is a temporal order. This means that it has two main features, the fact that it is an order and the fact that a temporal element is associated with it. The idea that B-series is an order, leads McTaggart to think that the before/after relations are permanent. This because an event that occurs before another one, in the series, will always occur systematically before this latter one. There is no way to change this, as previously underlined. Moreover, the characteristic of being an order is inherited by the B-series from the so-called C-series (which is just an order and has nothing to do with time; Mc Taggart's example is the series *x*, *y*, *z*. In this case, *y* is between *x* and *z*, while *x* occurs before *y* and *z* occurs after *y*). Furthermore, B-series inherits the temporal aspect from the A-series. Therefore, since B-series derives from A-series, this latter one grounds B-series and is more fundamental than the B-series.

> We may sum up the relations of the three series to time as follows: The A and B series are equally essential to time, which must be distinguished as past, present and future, and must likewise be distinguished as earlier and later. But the two series are not equally fundamental. The distinctions of the A-series are ultimate. We cannot explain what is meant by past, present and future… The B series, on the other hand, is not ultimate. For, given a C series of permanent relations of terms, which is not in itself temporal, and therefore is not a B series, and given the further fact that the terms of this C series also form an A-series, and it results that the terms of the C series become a B series, those which are placed first, in the direction from past to future, being earlier than those whose places are further in the direction of the future… It is only when the A-series, which gives change and direction, is combined with the C series, which gives permanence, that the B series can arise.[2]

From this quote, we appraise that direction and change are the main characteristics of A-series and these are overlaid on the C-series to form the B-series. Therefore, it would be impossible to talk about time without A-series. And to demonstrate that time does not exist, McTaggart uses a smart argument to highlight that A-series implies an inherent contradiction. In broad terms, the argument says that past, present and future are incompatible but each event has all of them since each event has been in the future, is in the present and will be in the past. «Thus all the three incompatible terms are predicable of each event, which is obviously inconsistent with their being incompatible, and inconsistent with their producing change».[3] McTaggart is aware of the fact that each event contains all the three elements of A-series not simultaneously. But he finds paradoxical that to clarify the idea that an event could be in the past, present or future in a not-simultaneous way, one needs to use the ideas of past, present and future. In other words, A-series could only be understood in terms of another A-series. This generates a circular argument and leads McTaggart to think that time does not independently exist. Indeed, time is needed to account for the A-series and A-series is needed to account for time, as we have seen previously.

[1] J.E. McTaggart, "The unreality of time", *Mind* vol. 17, n. 68 (1908): pp.457-474.
[2] *Ivi,* pp. 463-464.
[3] *Ivi,* p. 468.

Therefore, A-series is needed to account for A-series. This puzzling result represents the core of McTaggart's argument and one of the most important philosophical studies on time that have paved the way for further speculations like Gödel's ones.

3. Is the existence of time relative?

I just considered McTaggart's theory of the unreality of time, which background is purely philosophical. This latter perspective together with Einstein's studies on Relativity influenced Gödel's viewpoint on time. Indeed, Gödel is persuaded that «The concept of existence… cannot be relativized without destroying its meaning completely».[4] The idea that time is relative has its roots in Einstein's Theory of Relativity and the Twin Paradox clarifies this issue. Indeed, the Twin Paradox demonstrates that it is impossible to talk about absolute time, which is constant in the entire universe. In the next lines, I will consider the main features of the Twin Paradox to highlight the relativity of time.

The Twin Paradox tells us the story of two twins that go back and forth between two stations. The paradox is generally evaluated from two different perspectives. Indeed, both the experience of the first twin and the second twin is taken into account. Moreover, it should be underlined that at the beginning and the end of the story the twins are together and only one of them moves back and forth. Well, the trajectory covered by the first twin consists of departing from the meeting point, where the twins are together, reaching a very far station (travelling at speed light) and go back to the meeting point. The surprising result of this argument is that when the two twins meet again, the first brother is almost as old as it was before the departure time, while the second one seems to be way older than the first twin. And, at the end of the experiment, their clocks measure different times. With the first brother's clock measuring 1,25 years and the second brother's one measuring 2,50 years. Therefore, there is no accordance between the first twin's measurements and the second twin's ones. This occurs because the first twin is no more in an inertial state or rectilinear uniform motion as the second brother when he leaves. Indeed, taking the first train, the first twin accelerates and leaves the time frame of his brother. Therefore, the two twins do not share anymore the same frame of reference. Moreover, according to the Theory of Special Relativity, we have the same physical laws for all the inertial reference frames (i.e. not subjected to acceleration). But in this case, we have two different reference frames being the first twin subjected to acceleration. In addition, the first brother follows the rules of General Relativity according to which gravity has a fundamental role. In conclusion, we need to draw two consequences from this paradox: the fact that Special Relativity cannot be applied to all the variety of cases that occur in physics and that while space-time for Special Relativity is linear, for General Relativity space-time is curved. To clarify this, while in the case of Special Relativity we could approximate local space-time on a two-dimensional plane (flat surface) as something linear, in the case of General Relativity we consider the universe in its entirety on a large scale; thus, space-time cannot be approximated to a linear one. Anyway, except the technical aspects of the Twin Paradox, what appears to be important here is the fact that time is relative to the reference frame, which supports the idea that time is not absolute.

[4] P.A. Schilpp – K. Gödel, *A Remark About the Relationship Between Relativity Theory and Idealistic Philosophy*, Harper & Row, New York, 1949.

4. Gödel's universe

As we considered previously, Gödel said that the concept of existence cannot be relativized otherwise it would be annihilated. But we have also seen that the Twin Paradox shows us that time is relative and two observers must share local physical laws to have the same time experience. To do that, they must be in the same frame of reference. For this reason, absolute time does not exist. In support of this thesis, Kurt Gödel conceived his peculiar solution to Einstein's field equations of gravitation, which implies a kind of universe that rotates.

In *An Example of a New Type of Cosmological Solutions of Einstein's Field Equations of Gravitation,* written in 1949, Gödel proposes a solution that implies a four-dimensional space called S and rotating matter.

Gödel's solution has several properties but what interests us are two main points highlighted by Gödel. The first one is the fact that in this solution time travels are possible (implying that time is not always linear) and the second one is that absolute time is refuted. Indeed, Gödel specifies that:

> It is not possible to assign a time coordinate *t* to each space-time point in such a way that *t* always increases if one moves in a positive time-like direction; and this holds both for an open and a closed time coordinate… Every world line of matter occurring in the solution is an open line of infinite length, which never approaches any of it's preceding points again; but there also exist closed time-like lines. In particular, if P, Q are any two points on a world line of matter, and P precedes Q on this line, there exists a time-like line connecting P and Q on which Q precedes P; i.e., it is theoretically possible in these worlds to travel into the past, or otherwise influence the past… an absolute time does not exist, even if, it is not required to agree in direction with the times of all possible observers (where "absolute" means: definable without reference to individual objects, such as e.g., a particular galactic system).[5]

As I previously considered, time travels and the rejection of absolute time are the characteristics of Gödel's rotating universe. The idea of travelling into the past is clearly explained when Gödel talks about closed time-like lines. Indeed, these lines express circular time and time is no more linear only. Being circular time admitted, we are therefore allowed to modify our past or simply reach it.

Gödel's argument is at the same time controversial and fascinating and leads the way to new scenarios. These do not occur in our expanding universe where time travels are not possible. Indeed, generally, expanding universe is linked to cosmic time, which is used to make measurements on how the universe progresses.

Of course, cosmic time cannot be associated with Gödel's universe since in this latter one all the universe lines (which are the trajectories of objects in the space-time) are not orthogonal to foliated space planes and parallel to other universe lines, as cosmic time model suggests. On the contrary, they should be imagined in their singular trajectory that is no more linear but curved because the universe rotates on itself. Therefore, since the abovementioned universe rotates on itself, universe lines rotate; in this way, some lines are circle-shaped.

Of course, time travels are also linked to some paradoxes. Among these, I briefly mention the grandfather paradox, one of the most important and infamous. According to the latter one, a grandson

[5] K. Gödel, "An Example of a New Type of Cosmological Solutions of Einstein's Field Equations of Gravitation", *Reviews of Modern Physics* vol. 21, n. 3 (1949): pp. 447-450.

reaches the past and kills his grandfather prior he would be able to generate his son. This, of course, is impossible and generates a paradox.

Other paradoxes will not be examined being out of the scope of this paper. But one thing I need to underline is that paradoxes and time travels are in line with mathematics in certain perspectives like the Gödel's one. Thus, my next question is: what if mathematics tells us what exists?

5. Mathematical Platonism

The dispute about the existence of mathematical objects and the truth of mathematical statements is a very long one and has involved a huge number of scholars. I will not consider in details all the aspects of this dispute since it is not the theme of this paper. But I will take into account just the two main realist perspectives about mathematics. These two perspectives are mathematical realism and mathematical Platonism. While mathematical realists believe that mathematical objects exist like physical entities, i.e. atoms and mathematical statements could be true or false depending on the various properties of mathematical objects, mathematical Platonism involve the existence of an abstract dimension too.

In general terms, Stanford Encyclopedia of Philosophy tells us that

> Platonism about mathematics (or *mathematical platonism*) is the metaphysical view that there are abstract mathematical objects whose existence is independent of us and our language, thought, and practices. Just as electrons and planets exist independently of us, so do numbers and sets. And just as statements about electrons and planets are made true or false by the objects with which they are concerned and these objects' perfectly objective properties, so are statements about numbers and sets. Mathematical truths are therefore discovered, not invented.[6]

In other words, Stanford Encyclopedia of Philosophy explains clearly two things, i.e. that according to mathematical Platonism mathematical entities exist and mathematical truths are thus discovered and not invented. This means that mathematical objects are something that exists independently from our mind and in another realm, which is not actual. The abovementioned realm is not physical and mathematical objects are not subject to the same Spatio-temporal order known by physics.

I just want to clarify a few other aspects of this supposed abstract mathematical dimension. Indeed,

> Following some of what Plato had to say about His Forms, many thinkers have characterized mathematical entities as abstract – outside of physical space, eternal and unchanging – and existing necessarily – regardless of the details of the contingent make-up of the physical world. Knowledge of such entities is often thought to be a priori – sense experience can tell us how things are, not how they must be – and certain – as distinguished from fallible scientific knowledge. I will call this constellation of opinions "traditional Platonism".[7]

Anyway, Linnebo clarifies that contemporary mathematical Platonism has little to do with Plato. Indeed, contemporary mathematical Platonism is a mere metaphysical view and has no relationship with epistemology. Moreover, not all the contemporary mathematical platonists think that mathematical truths are necessary; this latter modal claim is not shared by all of them. Similarly, Maddy in *Realism in*

[6] Ø. Linnebo, *Platonism in the Philosophy of Mathematics*, in *The Stanford Encyclopedia of Philosophy*, E.N. Zalta (Ed.), (Spring 2018 Edition). URL = <https://plato.stanford.edu/archives/spr2018/entries/platonism-mathematics/>.

[7] P. Maddy, *Realism in Mathematics*, Oxford University Press, Oxford, 1990.

Mathematics specifies that even though the name “mathematical Platonism” evocatively suggests a link between this perspective and Plato’s thoughts about universals, the platonic element has generally been lost by mathematical platonists.

Another aspect should be considered here, to complete the general overview of mathematical Platonism. To be more specific, there are two main forms of mathematical Platonism. One of them is attributed to Quine and Putnam and is based on the Indispensability Argument, according to which being mathematics indispensable in science we have to commit to the existence of mathematical entities. The other one is Gödel’s mathematical Platonism, which will be considered in the next paragraph.

6. Gödel’s mathematical Platonism

First of all, I will need to underline that Gödel’s Platonism regarding mathematical objects is a philosophical perspective that grounds his theories. Indeed, I believe that each mathematical theory produced by Gödel assumes his Platonism. Therefore, his invaluable mathematical contribute must be read in light of the abovementioned presupposition. Moreover, being Gödel a mathematician, he grounds his mathematical Platonism on the practice of mathematics. And he thinks that the existence of mathematical objects is obvious. In other words, Gödel believes that since through the practice of mathematics, we discover mathematical objects thanks to intuition, they exist. The role of Gödel’s intuition is «analogous to that of sense perception in the physical sciences, so presumably axioms force themselves upon us as explanations of intuitive data much as the assumption of medium-sized physical objects forces itself upon us as an explanation of our sensory experience».[8] In other words, Gödel thinks that similar to what happens when sensory experience shows us the existence of physical objects, our intuition reveals us the existence of mathematical objects.

An abstract mathematical universe.

Till now, I have evaluated the various aspects of Gödel’s mathematical Platonism, now I will consider some of his passages on the theme.

With regards to this, in the paper *What is Cantor's Continuum Problem?* (1964) there are a few hints of his mathematical Platonism.

Indeed, in the abovementioned paper, we can understand in a very clear way that propositions about an abstract mathematical object are either true or false. This, strongly suggests that there is a realm of mathematical objects regarding which each substantial proposition could only be true or false. Linnebo explains the passage in this way:

> In his 1947 “What is Cantor's Continuum Problem?”, Gödel expounds the view that in the case of meaningful propositions of mathematics, there is always a fact of the matter to be decided in a yes or no fashion. This is a direct consequence of realism, for if there exists a domain of mathematical objects or concepts, then any meaningful proposition concerning them must be either true or false. The Continuum Hypothesis is Gödel's example of a meaningful question.[9]

Anyway, the main place where Gödel talks about his Platonist perspective is in the work *The Philosophy of Bertrand Russell* where he talks about his mathematical Platonism in this way:

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[8] *Ivi*, p. 31.

[9] J. Kennedy, *Kurt Gödel*, in *The Stanford Encyclopedia of Philosophy*, E.N. Zalta (Ed.), (Winter 2020 Edition) forthcoming URL = <https://plato.stanford.edu/archives/win2020/entries/goedel/>.

> Classes and concepts may, however, also be conceived as real objects, namely classes as "pluralities of things," or as structures consisting of a plurality of things and concepts as the properties and relations of things existing independently of our definitions and constructions. It seems to me that the assumption of such objects is quite as legitimate as the assumption of physical bodies and there is quite as much reason to believe in their existence. They are in the same sense necessary to obtain a satisfactory system of mathematics as physical bodies are necessary for a satisfactory theory of our sense perceptions and in both cases, it is impossible to interpret the propositions one wants to assert about these entities as propositions about the "data", i.e., in the latter case the actually occurring sense perceptions.[10]

Again, Gödel explains that abstract objects (in this case the mathematical ones) exist in the same way physical objects exist, i.e. independently from our mind. Indeed, the main point I want to stress here is that mathematical objects for Gödel do not exist in our mental dimension. Instead, they exist in another dimension, i.e. the abstract one.

7. Conclusion. Gödel's rotating universe, mathematical Platonism and unreality of time

In conclusion, this paper aims to highlight that from Gödel's perspective, the unreality of time is not only a matter of physics. Indeed, according to Gödel's philosophical viewpoint, the unreality of absolute time is supported by mathematics too. The rotating universe exists in the abstract mathematical realm and it has been discovered by Gödel, according to his line of thought. In other words, I argue that Gödel, according to his philosophical perspective, believes to have found another universe that is in a mathematical realm, where all the matter rotates since he is a Platonist about mathematical objects and mathematical truths. This means that another temporal dimension exists in the abstract realm, thus another temporal dimension exists in general since for Gödel the abstract mathematical realm exists. In this sense, Gödel's rotating universe exists and his idea on the unreality of time is closely linked to his mathematical Platonism.

[10] K. Gödel, *Russell's mathematical logic*, in P. Schilpp (Ed.), *The Philosophy of Bertrand Russell* (Library of Living Philosophers), Tudor, New York, 1951.