Presentism and the Multiverse Hypothesis*

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Abstract

The special theory of relativity (STR) is often used to oppose presentism because STR denies the existence of absolute simultaneity. According to the general theory of relativity (GTR), which generalizes upon STR, we can consider the notion of ‘cosmic time’, which is common to the whole universe. Accordingly, cosmic time could be a candidate for absolute time, which would provide a means for presentism to be maintained. Nevertheless, GTR can also be said to be incomplete because it is not unified with quantum mechanics (QM). In this paper, I argue that if a certain variety of the multiverse hypothesis is correct, then presentism cannot be supported.

Key words: presentism; multiverse; relativity theory; quantum mechanics.

1. Introduction

Presentism is one of the major ontological views of time, which states that only present things exist. Although this view agrees with our intuition well, it is frequently said that presentism and the special theory of relativity (STR) are incompatible because STR rejects such relationships as absolute simultaneity [1], [2, pp.42ff.]. Consider that there are two observers, $O_1$ and $O_2$, moving with different velocities (thus, they are different inertia systems). Both observers arrive at point $A$ in the present, and event $E_A$ occurs at $A$. In addition, event $E_B$ also occurs at a point $B$, which is spatially separated from $A$. The occurrence of $E_B$ is simultaneous with $E_A$ for $O_1$. This implies that $E_B$ is a present event for $O_1$; thus, $E_A$ and $E_B$ exist for $O_1$. However, according to the STR, $E_B$ does not occur simultaneously with $E_A$ for $O_2$; thus, $E_B$ is not a present event, and it does not exist for $O_2$. It follows from this result

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that which event exists depends on who is observer. Nevertheless, this consequence is clearly unacceptable.

There are two possible responses from presentists to this criticism: (a) denying STR, or (b) denying that STR actually entails that there can be no such thing as absolute simultaneity. Most presentists seem to prefer option (b) [3, section 5].

Markosian, a proponent of presentism, whose response to the above challenge follows option (b), summarizes the criticism of presentism by appealing to STR as follows [4, section 3.9]:

The Argument from Relativity (AFR)

1. STR is true.
2. STR entails that there is no such relation as absolute simultaneity.
3. If there is no such relation as absolute simultaneity, then there is no such property as absolute presentness.
4. Presentism entails that there is such a property as absolute presentness.

Presentism is false.

Markosian then considers two possible versions of STR: namely STR\(^+\) and STR\(^-\):

STR\(^+\) = A philosophically robust version of STR that has enough philosophical baggage built into it to make it either literally contain or at least entail the proposition that there is no such relation as absolute simultaneity.

STR\(^-\) = A philosophically austere version of STR that is empirically equivalent to STR\(^+\) but does not have enough philosophical baggage built into it to make it either literally contain or entail the proposition that there is no such relation as absolute simultaneity.

Markosian states that while premise (1) is false if AFR concerns STR\(^+\), presentists can legitimately deny premise (2) if AFR concerns STR\(^-\). Therefore, one need not conclude that presentism is incorrect.

The point of the rebuttal from presentism is that it is false to equate the empirical adequacy of a theory with the validity of the ontological implications of that theory. Consequently, the empirical success of STR does not require abandoning presentism.

This discussion is logically valid. Nevertheless, it is also true that accepting presentism implies accepting the incompleteness of STR because presentism insists that there is something whose counterpart STR does not possess. For example, Saunders states, ‘[s]pecial relativity, presentists must conclude, is radically incomplete’ [1, p. 282].

At the first glance, it seems problematic for presentists to accept the incomplete-
ness of STR because STR is a widely successful theory. However, we can state that STR is actually incomplete in the sense that STR takes into account only inertial systems. In this paper, I show that it is possible to support presentism when we consider the general theory of relativity (GTR). However, I also argue that it is difficult to support presentism when we take into account a certain variety of the multiverse hypothesis.

2. Presentism and the General Theory of Relativity

Let us consider GTR in this section. GTR is a theory that considers both inertial and non-inertial systems, whereas STR only considers inertial systems. Therefore, at first glance, GTR is more generalized than STR, and thus the existence of absolute simultaneity must be also rejected in GTR. However, in actuality, GTR offers us a candidate for an absolute frame of reference. Furthermore, if we have an absolute frame, then we can determine relations of absolute simultaneity between two events that are spatially separated, and in this way we can protect the doctrine of presentism.

As is well known, most cosmologists agree that our universe is expanding. This fact implies that there must have been a beginning to the universe, and cosmologists estimate that 14 billion years have passed since the birth of the universe. However, on which frame do they measure the age of the universe? For example, Morris (1985, p.174) says:

Incidentally, the concept of the age of universe does have a precise meaning even though the special theory of relativity implies that time measurements are relative. General relativity is, paradoxically, less relativistic than the special theory. Although it does not contradict what special relativity says about time measurements made by different observers, it does allow one to define a cosmic time that can be applied to the universe as a whole.

Cosmic time is the time that would be measured by an observer who was moving along with the average expansion of the universe. [5, p.174]

Thus, cosmic time is a strong candidate for absolute time. It is not so important here whether or not cosmic time is really absolute time. The important point is that we can suggest a concrete candidate for absolute time (thus making possible the existence of absolute simultaneity) in GTR, despite the fact that we can find no such concrete candidate in STR. Therefore, presentists are not faced with a choice: the acceptance of the incompleteness of GTR or the rejection of presentism.
3. Presentism and Quantum Mechanics

There might be a way to determine simultaneity other than the optical way in which Einstein demonstrated the relativity of simultaneity between spatially separated events based on STR. Zimmerman points out that the non-local correlation that appears in quantum measurements can be one such candidate [6, p.186]. Zimmerman argues that even if we accept quantum mechanical simultaneity based on non-local correlation and add it to STR, it does not undercut the empirical success of STR; he quotes Maudlin as follows:

[N]o positive part of the relativistic account of space-time is being rejected: rather, in addition to the Lorenztian metric, a new structure is being added. Because of this, there is a straightforward sense in which no successful relativistic account of any physical phenomenon need be lost or revised; if something can be accounted for without the foliation, then one need not mention it. Thus, there is no danger that existing adequate relativistic accounts of phenomena will somehow be lost: in this sense, the content of relativity is not being rejected at all. [7, p.160]

In sum, quantum mechanics (QM) implies that there is a way to determine absolute simultaneity other than an optical way. Additionally, STR is actually not a complete theory in the sense that it is not unified with QM. Furthermore, as Maudlin and Zimmerman say, addition of the special foliation to STR does not alter the theory at all.

4. Presentism and Multiverse Hypothesis

In sections 2 and 3, I examined the relationship between presentism and GTR, as well as the relationship between presentism and QM. Both GTR and QM seem to be able to offer us a way to determine absolute simultaneity. However, as Callender points out, even if the GTR or QM provides a preferred foliation, there is no reason to consider that this foliation is also preferred by presentists [8, pp.65f]. In addition, both GTR and QM are incomplete in the sense that they have not been unified yet. Although we have not yet arrived at the final theory, some interesting views of space-time have been articulated in the various attempts at such unification. One such view is the multiverse hypothesis, which insists that there are many universes other than our own. Three important varieties of the multiverse hypothesis can be stated as follows (see [9]–[12]).

(1) In 1981, Sato and Guth independently suggested an (old) inflation model [13], [14]; after that, Linde and Albrecht–Steinhardt independently offered a new inflation model (see, for example, [9, ch. 12]). According to the new model, inflations
continue eternally in many different areas; thus, many universes (pocket universes) are created. Since the inflation model can explain how the Big Bang occurred, it is widely accepted in the scientific community. (Recent observations by the Wilkinson Microwave Anisotropy Probe (WMAP) also provide scientists with grounds for believing in this theory.) These pocket universes are considered to be causally independent from each other. Therefore, time flows differently in different universes. It follows that we cannot determine which is the absolute frame even if there exists a cosmic time or quantum entanglement in each universe. However, there must have been a first universe, which is called the mother universe, and was followed by the other pocket universes. Consider two particles that are entangled in the mother universe, which are then separated into different universes. The state of the first particle collapses when one of them is measured in one universe; furthermore, at the same time the state of other particle in the other universe also collapses. Consequently, we can define absolute simultaneity among the different universes via quantum measurements.

(2) In the late 1990s, scientists found that superstring theory admits of many solutions, and that there are many universes corresponding to these solutions (referred to as ‘the landscape of superstring theory’). These universes are also causally independent from each other.

(3) Vilenkin and Hartle–Hawking claim that our universe was born from nothing through quantum tunnelling [15], [16]. This hypothesis implies that there must be many universes other than our own (i.e. there must be many other universes created from nothing). Universes are causally independent from each other in this version of the multiverse hypothesis as well. Although this hypothesis is accepted by fewer scientists than (1) and (2), it should be noted that these three hypotheses do not contradict each other. Although presentism is still one of the most viable ontological views of time (along with other views, such as eternalism) if the eternal inflation model (1) is correct, presentism has little persuasiveness if the hypothesis of creation from nothing (3) is correct. That is because there is no common frame between the universes created from nothing.

Concerning multiverse hypothesis (2), many physicists (such as Susskind, Vilenkin, and Guth) combine the landscape and the eternal inflation model (e.g. [10, ch. 11, note 1]). While the notion of landscape is abstract, the eternal inflation model offers a model of the real multiverse. Thus, physicists consider each solution of superstring theory to have a counterpart to each quasi-stable vacuum in the eternal inflation model. If they are correct, then the second variety of the multiverse hypothesis (type (2) above) also possibly contains absolute simultaneity. However, the inflation model cannot identify the very moment of the beginning of the universe(s). At this stage, the hypothesis of Vilenkin and Hartle–Hawking is the only one that shows how the universe(s) began. A common inertial frame cannot possibly exist if
the universe was born from nothing, and thus we cannot maintain presentism.

5. Presentism and Ekpyrotic Universe

At this stage, it should be mentioned that we have some alternatives to the inflation model, such as the ekpyrotic universe [17]. This model suggests one variety of the cyclic universe, and does not seemingly assume the multiverse. It instead assumes the existence of many ‘braneworlds’, but they exist on a dimension that is common to our braneworld, and they sometimes crash with each other (which was the cause of the Big Bang). Steinhardt and Turok insist that it is possible to determine which is superior — the inflation model or the ekpyrotic model — by observing the gravitational wave that was created before the universe became ‘transparent’ — i.e. before photons could freely move — because we cannot know how the universe was before this time using electromagnetic investigation techniques.

However, even if this model is correct, it does not necessarily follow that there are no universes that have no dimensions common to our own universe. That is because this model does not solve the problem of how our universe began, similarly to the inflation model.

If the universe is perfectly cyclical, which means that exactly the same universe was born repeatedly, we can conclude that there is no beginning because we cannot distinguish one iteration of the universe from another. However, according to the ekpyrotic model, various iterations of the universal cycle are different from each other, and thus this model is not perfectly cyclical. Hence, it is strongly doubtful that there is no beginning. Therefore, Vilenkin (as well as Hartle and Hawking) still can accept the ekpyrotic model, and the Vilenkin and Hartle–Hawking model is still a unique candidate for explaining the very beginning of the universe, although it is not widely accepted.

It is not important whether the mechanism by which the universe(s) came into existence from nothing (as shown in the Vilenkin and Hartle–Hawking model) is correct or not. The point is simply whether or not the universe(s) was born from nothing.

Suppose that the universe that is not perfectly cyclical and has no beginning. Such a universe has existed since the infinite past. However, it follows that an infinite series of events has occurred in such a universe, though this is impossible (if the presentism is correct). Therefore, if the universe is not perfectly cyclical, then it must have a beginning. Moreover, if the universe began in the finite past, the universe must have been created from nothing because there was nothing before the universe began. Furthermore, if creation from nothing is possible (however small that probability may be), creation must have happened many times. The prerequisite to accept the possibility of the creation from nothing is to accept the existence of nothingness.
Here, nothingness implies that even space and time do not exist. In other words, the volume of space equals exactly zero. Therefore, we can say that there is plenty of nothingness because the volume of a large amount of nothingness whose volume is zero is still zero. Hence, creation from nothing must have occurred many times aside from the creation of our universe. In conclusion, presentism cannot be held except in the perfectly cyclic universe.

6. Conclusion and Discussion

In this paper, I discuss whether modern physics allows for the possibility of absolute simultaneity, whose existence is essential for presentism.

Recently, scientists have been accepting hypotheses stating that there are many universes other than our own. These hypotheses are obtained via attempts to unify GTR with QM. Roughly speaking, there are three varieties of the multiverse hypothesis, which are derived from (1) eternal inflation theory, (2) superstring theory, and (3) the hypothesis that universe was created from nothing. Since the eternal inflation theory implies that there is a mother universe from which all other universes, including our own, appear, it does not reject the existence of absolute simultaneity. In addition, the universes considered in (2) are usually identified with those in (1).

However, the inflation model is not a theory that indicates the beginning of the universe. If our universe was created from nothing, as Vilenkin and Hartle–Hawking insist, then absolute simultaneity does not exist, and thus presentism has little persuasion when we seriously take scientific theories into account.

Nevertheless, proponents of presentism might reply to my challenge as Bourne does [18, pp. 175–176]. He holds that (emphasis by the author)

I suggest this: first, we do understand what it is for ourselves to be absolutely present and for present-tense propositions to be absolutely true, for it is not possible for us to be anything but correct about whether we are present, if we are presentists: if we exist, we are present. Second, simultaneity is defined in terms of the conjunction of present-tensed proposition.

However, Bourne’s argument is question-begging, as it is valid only when presentism is correct. The moment when we exist is not necessarily present if presentism is false.

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