Interview with Philippe de Bellescize
Author of the book
Paradox on the Invariance of the Speed of Light (1)
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By Alain Pelosato

Philippe de Bellescize, I have always learned that the speed of light in a vacuum is constant, whatever the reference frame, ever since Einstein's special relativity… This constant also applies to other phenomena, such as gravitational waves, knowing that by "light" I mean all electromagnetic waves. In your book, you challenge the idea that this speed is a constant.

I believe that Einstein, following the Michelson–Morley experiment, went down the wrong path. Here is what I say about this in my book:

It was once thought that the speed of light was invariant with respect to the ether, and therefore could not be invariant with respect to the Earth. The Michelson–Morley experiment was supposed to confirm this. Surprisingly, it seems, on the contrary, to indicate that the speed of light is invariant with respect to the Earth. From there, Albert Einstein no doubt arrived at something like the following reasoning: if the speed of light is invariant with respect to the Earth, whereas the Earth is a moving body, then it must be invariant with respect to any body in an inertial state. If one takes into account the train thought experiment, this amounts to saying that if the speed of light is invariant with respect to the station, then it must also be invariant with respect to the train moving at constant velocity relative to the station. As one will notice when reading this book, this reasoning is partly inaccurate. We shall see that it is more correct to think—although the origin of this is not immediately obvious—that there is a constant adaptation of the speed of light to the spatial configuration (2).

Physicists know that the invariance of the speed of light implies the relativity of simultaneity: two distant events that are simultaneous for a first observer "at rest" would not be simultaneous for a second observer moving at constant velocity relative to the first. But they have not necessarily realized that this idea leads us, in certain cases, to what I call "the principle of relativity of simultaneity at the physical level": the same object, located at a distance from two observers who pass by each other, is supposed to exist with respect to the first observer but not with respect to the second. Since this principle, together with the shuttle-and-missile objection, results in a contradiction, it cannot correspond to what actually

happens. As readers will understand from my latest book, this observation challenges the postulate of the invariance of the speed of light.

To do this, you revisit Einstein's train thought experiment (3), which concludes that, whatever the reference frame, the speed of light is always the same… You deduce from your reasoning that one must "change the representation of space-time."

The invariance of the speed of light leads us, via the principle of relativity of simultaneity at the physical level, to the block universe, in which there is no longer a present moment for the Universe nor any real unfolding of time. Indeed, in the train thought experiment, while the two observers are at "the same position," if the light ray at the rear of the train already exists with respect to the observer on the platform but not yet with respect to the observer on the train, then, regarding that light ray, the train observer's time is already written. But ultimately, by discovering through the shuttle-and-missile objection that the principle of relativity of simultaneity at the physical level leads to a contradiction, we understand—since there is no third possibility—that there is in fact absolute simultaneity (4). With absolute simultaneity, the speed of light cannot be invariant in certain situations.

You are therefore challenging quite a lot. For example, in the space-time metric (+++- or —+), the "time" coordinate is "spatialized" by multiplying time by the speed of light (ct). What happens if "c," the speed of light, is no longer a constant?

Time, in relativity, is considered as a dimension just like the three others. It is the postulate of the invariance of the speed of light that leads us to this representation. But once one discovers that there is in fact absolute simultaneity and thus a present moment for the Universe, this completely transforms our approach to space-time. The speed of light can only be locally invariant with respect to the Earth (except for the Sagnac effect). Since this must also be true for another planet with the same mass as Earth, this amounts to saying that there is a constant adaptation of the speed of light to the spatial configuration (5). This may lead us to a fully relational conception of space-time and motion. In such a conception, it is the evolution of the current relationship between bodies that causes motion. This perspective allows a possible redefinition of the foundational concepts of physics.

What about the Lorentz transformations, which you use on page 37 in the appendices of your book?

The Lorentz transformations are the mathematical consequence of the postulate of the invariance of the speed of light. I simply provide them as an illustration, since I did not need to study these transformations to arrive at my reasoning. Indeed, admitting the relativity of simultaneity means that each observer has a line of simultaneity (6) with a particular orientation. This orientation depends on the velocity of the observer. The farther one moves from the intersection point of two lines of simultaneity, the greater the "simultaneity offset" between the two lines. For an observer who accelerates, there is a rotation of his line of simultaneity. He may thus, in certain situations, travel back in time if one considers events

sufficiently far from him. This is not acceptable once one takes into account the existence of physical bodies.

In special relativity, the observer can travel back in time only along his line of simultaneity for events located very far away. But with general relativity, things go even further, as there could be semi-closed time-like loops: for example, a billiard ball that could theoretically strike its duplicate in its own past (7). One observes a duplication of reality whose origin is precisely the principle of relativity of simultaneity at the physical level. It is premature to say that there is no paradox, for one would then end up with two billiard balls instead of one (8).

Even if these considerations show that we must change paradigms, the old formalism may retain a domain of validity. Even if the relativity of simultaneity is fictitious, it can, in some cases and approximately, replace a difference in the speed of light. For example, within the framework of absolute simultaneity: if the speed of light is locally invariant with respect to the station—something not necessarily true in all cases—then it cannot be invariant with respect to the train in motion relative to the station. In this case, in Einstein's train thought experiment, the delay regarding the emission of the light ray at the rear of the train, for the observer in the train, corresponds to a difference in the speed of light relative to the train (9).

The constant "c" also appears in the constant of Einstein's general relativity equation ($8\pi G/c^4$). What happens then? And what about GPS calculations?

With general relativity, regarding the "slowing down of the passage of time," there is a double reasoning: one that comes from special relativity, whose origin is the relativity of simultaneity; and the other which comes from gravity (10). I only argue that the first aspect does not correspond to what actually happens.

In fact, one can only speak of a slowing down of time if one admits absolute simultaneity. Only within such a framework can one compare two different "flows" of time. In special relativity, there is no real slowing down of time but rather two different space-time paths.

A satellite clock is not subject to gravity in the same way as a clock on Earth, which is why their rates differ. Two "identical" clocks placed in different spatial conditions may very well tick simultaneously at different rates. One cannot arbitrarily dismiss this possibility (11). Moreover, I believe that, for satellites, a synchronization protocol is included in the exchanges, which may slightly modify things.

Once one understands that we must abandon the conception of time in special relativity, one may ask on which conceptual postulate a new approach to space-time could rest. I address this topic in my open letter to Lee Smolin at the end of the book. This opens an immense interdisciplinary field of research.

Notes

(1) Paradoxe sur l'invariance de la vitesse de la lumière, Chapitre.com, December 2020.

(2) Paradoxe sur l'invariance de la vitesse de la lumière, p. 9.

(3) Albert Einstein, Relativity, Petite bibliothèque Payot, 2016.

(4) "Two events are actually simultaneous or not."

(5) The Shapiro effect could be interpreted in this framework.

(6) Line of simultaneity: what is supposed to be simultaneous for an observer.

(7) Marc Lachièze-Rey, Voyager dans le temps, Seuil, 2013.

(8) Mentioned in a circular letter cited in the English edition.

(9) Philippe de Bellescize, Paradoxe…, p. 29.

(10) Gravity slows the rhythm of clocks.

(11) With absolute simultaneity, the twin paradox must be reconsidered.