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Physicists Calculate But Do Not Explain 3/7

Interconverting between space and time.

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Abstract.-The practically insurmountable difficulties of the interconversion between space and time are discussed here when this interconversion is not posed in mathematical terms, but in real physical terms. The supposed symmetry between space and time of the spacetime continuum is also questioned in the same real physical terms.

1. The continuum spacetime

The spacetime continuum (which does not appear in Einstein's special relativity) was introduced by H. Minkowski [3, 4, 5], and although initially rejected by Einstein [6, p. 102]:

> Since the mathematicians have invaded the relativity theory, I do not understand it myself any more.

In the end, Einstein accepted spacetime, as have practically all physicists from that time to the present day. As is well known, spacetime is the non-numerable set of all quaternions of real numbers (x, y, z, t), in which the first three elements represent positions in space and the fourth positions in time. According to the relativistic orthodoxy there is a complete symmetry between space and time, so that it is possible to inter-convert them, a very popular inter-conversion that appears almost always in the secondary literature on the subject, for example [1, p. 79]. The physical, not mathematical, meaning of this interconversion is discussed here.

2. Space is a physical, real object

On September 14, 2015, the two U.S. LIGO interferometers detected gravitational waves for the first time. By March 2020, nearly one hundred different detections of gravitational waves had already accumulated in the global network of interferometers. Of course, gravitational waves are *real* vibrations that produce *real* effects in *real* instruments made of *real* ordinary matter. Consequently, the vibrating medium, space, must also be real. What does not exist cannot vibrate or physically interact with real physical objects producing empirically detectable changes, in this case by minimally varying the distances between the mirrors of the interferometers.

In my opinion, this reality of physical space is the most important consequence of the empirical detection of gravitational waves, although so far it has not even been considered by contemporary physics (ChatGPT4o reaches a similar conclusion). And like any real physical entity, space will have its own substantiality, which could be called space matter. Obviously, and taking into account the Principle of Inertia, space matter must be completely transparent to ordinary matter, and sensitive to its presence (gravitational fields)[1]. An immediate consequence of this substantiality of space is that space matter could be the only means of propagation of light, since 99% of the transparent ordinary matter, through which light also propagates, is also physical space.

3. Interconversion between space and time: a physical perspective

The physical reality of space would make it possible to define it in physical terms, for example:

> Space is a physical object, with physical properties that are empirically detectable and measurable, and whose substance is different from ordinary matter, which it contains and to which it is transparent and sensitive to its presence

[1] It could even be the case that the discrete units of space themselves originate the discrete units of ordinary matter, in the manner of cellular automata.

Obviously, this is neither a complete nor a definitive definition of space; it simply illustrates the possibility of defining it in terms of its physical properties and its physical behavior. That time is also a physical object is not yet clear; it could be a universal property of physical objects rather than a physical object; a property so basic that it is impossible to define it in terms of other more basic properties; i.e. time would be a primitive concept. We start, then, from an asymmetric situation to discuss the physical aspects of the interconversion between space and time (the interconversion factor would be the speed of light). In the following discussion the two alternatives for the nature of time (object or property) will be considered. But first it is worthwhile to make the following reflection.

Age is a property exhibited by all physical objects in the universe, ranging from thousandths of a second to billions of years. But, as we have just seen with the units of time just cited, the time of the spacetime continuum is not useful for measuring the age of physical objects, because that time is exclusively composed of instants (points of time) of zero extension (duration) and it happens that ALL the intervals of that continuous time have the same number of instants ($2^{\aleph_0}$ instants). So if the age of a physical object were to be expressed in terms of the instants of time elapsed since that object was formed, all objects in the universe would have the same age, which is not the case. Thus, to establish the actual age of objects, arbitrary metrics have to be used: seconds, days, years, etc. Metrics that cannot be expressed in terms of the instants that define time in the spacetime continuum!

Taking into account the physical reality of space, there can only be two alternatives for the interconversion between space and time:

1.- Time is a property of physical objects. In this case it would be a matter of converting a physical object (space), into a property of physical objects (time); and vice versa. Converting objects into properties and vice versa does not seem to make much physical sense.

2.- Time is a physical object. According to its theoretical model, the continuum of real numbers, it would have to be a one-dimensional physical object formed by units of null extension (instants). The physical interconversion process is far from being known, however well known its mathematical version may be.

Consequently, the immediate mathematical conversion between space and time of the spacetime continuum is not so immediate from the point of view of its physical interconversion, and space being a physical object, that interconversion must indeed be a physical interconversion. Moreover, for those who speak of this interchange and of the symmetry between space and time, it is worth reminding them of the enormous differences between both. For example, and assuming that all the involved objects belong to the same reference frame:

1.- In space, rest is possible; in time it is not.

2.- It is not possible for two physical objects to occupy the same space; it is possible in time.

3.- For a given inertial reference frame, the place (space) occupied by each of its physical object is different; time is the same for all these objects.

4.- Each direction of space can be traversed in its two senses; in time only in one sense.

5.- Space has electromagnetic properties (electric permittivity and magnetic permeability); time does not have electromagnetic properties.

6.- Space is impregnated with force fields (the four fundamental forces); time does not contain force fields.

7.- Space can vibrate; time cannot because it is unidirectional and one-way.

8.- In space it is possible to go and return to the same place an indefinite number of times; in time it is not.

9.- In space it is possible to periodically interchange the positions of any two physical objects; in time it is not.

10.- etc.

This brief discussion can be concluded by stating that the interconversion between space and time is more fictitious (mathematical) than real. An interconversion that, after all, would be between two elements of the same inconsistent set: the spacetime continuum (see [2]).

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