The Time of Photon Motion in Minkowski 4D space

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Abstract
Most physicists today still conceptualize time as a part of the physical space in which material objects move, although time has never been observed and measured as a part of the space. An altogether different concept of time has been developed in recent decades, one which negates the existence of time. Yet this concept has no answer to the fundamental question: if there is no time, what is it that is measured with clocks? The here presented "measurable time" is the time that is, in every experiment, measured with clocks. Measurable time is the numerical order $t_1,t_2...t_n$ of material change i.e. motion that is being measured with clocks. The fundamental unit of numerical order $t_1,t_2...t_n$ of material change is Planck time t_p. Photon moves in space only and not in time. Each Planck distance d_{px} that photon pass correspond Planck time t_{px}. In Minkovski 4D space where $X4 = i*c*t$ time t is the numerical order of photon motion.

Key words: space, time, numerical order of material change, run of clocks, photon motion, Minkowski 4D space

Introduction

Authors who negate the existence of time (1,2,3,4,5,6), cannot explain the fundamental physical phenomena, namely how to derive velocity v from the motion of an object on the distance d. A non-pragmatic concept of time like this one has no credibility to be an adequate model of the physical world. The measurable time as a numerical order of material change i.e. motion explains derivation of velocity v from the motion without considering time as a part of space. Let us take a photon moving on the distance d between a point A and a point B of space. Distance d is composed of Planck distances l_p: $d = \sum l_{p1} + l_{p2} ... + l_{pn}$. The smallest distance a photon can move on the way from A to B is l_p. The numerical order of motion from l_{p1} to l_{p2} is Planck time t_p. The photon is moving exclusively in space, not in time. In space "before" and "after" exist only as a numerical order $t_0,t_1,t_2...t_n$ of a physical event: t_{n-1} is "before" t_n just as the natural number $n-1$ comes "before" the natural number n. The numerical order of material change is measured by the "ticking" of a clock where t_0 represents the beginning of a measurement, t_n the end of a measurement. The velocity v of a material change is derived from its numerical order t_n: $v = \frac{d}{t_n} ms^{-1}$. The frequency γ of material change is derived from its numerical order t_n: $\gamma = \frac{1}{t_n} s^{-1}$. Velocity v and frequency γ of material change are functions of their numerical order t_n: $v = (f)t_n$, $\gamma = (f)t_n$ (7).

In the Special Theory of Relativity the fourth coordinate X_4 of space is spatial, too. X_4 is a product of imaginary number i, light speed c and the numerical order t_n of an event: $X_4 = i * c * t_n$. It is more correct to imagine the cosmic space as a four-dimensional $4D$ space than as $3D+T$ where the fourth dimension is time. Time is the numerical order of material change measured with clocks. The fundamental unit of numerical order $t_0, t_1, t_2 ... t_n$ of material change that take place in space is Planck time $t_p = 5{,}39124 * 10^{-44} s$ and is derived from the light speed: $t_p = \frac{c}{l_p}$ where l_p is Planck distance. Planck time t_p exists in the universe as a fundamental physical unit that governs numerical order of material change (8).

Space is space and time is time

In his paper "Time and Classical and Quantum Mechanics: Indeterminacy Versus Discontinuity" Lynds argues that between time and space there is always a difference: "The fact that imaginary numbers when computing space-time intervals and path integrals does not facilitate that when multiplied by i, that time intervals become basically identical to dimensions of space. Imaginary numbers show up in space-time intervals when space and time separations are combined at near the speed of light, and spatial separations are small relative to time intervals. What this illustrates is that although space and time are interwoven in Minkowski space-time, and time is the fourth dimension, time is not spatial dimension: time is always time, and space is always space, as those i' s keep showing us. There is always a difference. If there is any degree of space, regardless of how microscopic, there would appear to be inherent continuity i.e. interval in time" (9).

This paper demonstrates that the difference between space and time is the following: time is a numerical $t_0, t_1, t_2 ... t_n$ order of material change that take place in space.

Time as Fundamental Arena can be eliminated

In their paper "The Mathematical Role of Time and Space-Time in Classical Physics" Newton C. A. da Costa and Adonai S. Sant'Anna show that time as a fundamental physical arena in which material change take place can be eliminated: "We use Padoa"s principle of independence of primitive symbols in axiomatic systems in order to discuss the mathematical role of time and spacetime in some classical physical theories. We show that time is eliminable in Newtonian mechanics and that spacetime is also dispensable in Hamiltonian mechanics, Maxwell"s electromagnetic theory, the Dirac electron, classical gauge fields, and general relativity" (10).

In this paper, time is presented as a numerical order t_n of material change which we measure with clocks. The fundamental arena in which material changes take place is space. Measurable time measured with clocks is merely numerical order of material change.

“Killing time” is not necessary

In paper “Killing time” James F. Woodward discusses that time as we experience it is not part of fundamental reality: “Theoretical consequences of the gravitational origin of inertial reaction forces, that is, Mach's principle, are explored. It is argued that Mach's principle leads to the conclusion that time, as we normally treat it in our common experience and physical theory, is not a part of fundamental reality; the past and future have a real, objective existence, as is already suggested by both special and general relativity theory. A laboratory scale experiment whereby Mach's principle, and thus radical timeless ness, can be established is mentioned” (11).

In this paper it is shown that the “killing of time” is not necessary. We need an exact understanding of how time and space are interrelated. Time is the numerical order of material changes in space that itself is timeless: time is not part of space, space is 4D. Past, present and future physically exist only as numerical order of material changes that take place in timeless space. One can move in space only and not in time. Hypothetical travel in time is not possible.

Progress in understanding time in the last 300 years

Isaac Newton founded his classical mechanics on the view that space is something distinct from body and that time is something that passes uniformly without regard to whatever happens in the world. According to Newton, time passes in space and is not part of space. Absolute, true, and mathematical time, from its own nature, passes equably without relation to anything external, and thus without reference to any change or way of measuring of time. Newton has regarded space and time as real entities with their own manner of existence as necessitated by God's existence (more specifically, his omnipresence and eternality).

As to the existence of space as Newton sees it there is no doubt. Space is a physical medium in which matter exists. But as for his view on time there is no measurable evidence. Time running in space by itself has never been measurablely detected. On that fact my consideration is that such a time does not exist. Time that exists is the measurable time we measure with clocks. With clocks we measure numerical order of material change i.e. motion in space. Universe is not changing in time, on the contrary, time as a numerical order of change takes place in the universe. The universe is timeless. With clocks we measure the velocity of material change. For Newton these velocities are absolute in the sense that clocks run with equal velocity in entire universal space.

In his Special Theory of Relativity (SR), Einstein has described electromagnetic phenomena with a formalism of four-dimensional space created by German mathematician Hermann Minkowski. In his formalism, the fourth coordinate is $X_4 = i*c*t_n$. As in Newton's physics, also in SR the numerical order of material changes is we measured with clocks. Velocity v is calculated out of numerical order t_n: $v = \frac{d}{t_n}$. Experiments confirm that material changes (velocity of clock's mechanism included) have different velocities in different inertial systems. In SR, the velocity of material change is not absolute, it is relative. A more than hundred year misunderstanding of SR is that material changes take place in time as a part of space, and so time is a dimension of a medium in which electromagnetic waves, particles and massive bodies move. According to the formalism $X_4 = i*c*t_n$ time t_n is only a component of X_4 which we obtain with clocks. X_4 is spatial, too. In the

Special Theory of Relativity Space is not 3D + T. Space is 4D.

Time as a numerical order of change has no “arrow”. In SR, time is not pointed in the direction of X_4. In universe, time runs exclusively as a numerical order of material change, i.e. motion. Past $t_{-n}...t_{-2},t_{-1}$, present t_0 and future $t_1,t_2...t_n$ exist only as a numerical order of material change.

4D space is a medium of immediate information transfer by phenomena with numerical order zero $t_n = 0.$

According to the concept of space-time, all physical phenomena happen in space and time. This concept cannot explain those physical phenomena where information transfer is immediate. For these phenomena time t is zero. If phenomena would happen in time as some physical reality, time could never be zero. This article presents a new concept of space-time as 4D physical reality where measurable time obtained with clocks is only a numerical order of physical phenomena. Some physical phenomena have zero numerical order: $t_n = 0$. Physical phenomena characterized by zero numerical order are immediate information transfers carried directly by the 4D space. Examples of such phenomena are: the non-local correlations between quantum particles in EPR-type experiments and other immediate physical phenomena like tunneling or quantum communications regarding the continuous variable systems or the quantum excitations from one atom to another in Fermi’s two-atom system (12,13,14,15). Their velocity is always constant; namely zero (just as the constancy of light speed of special relativity). The zero speed in the immediate information transfer turns out to have an ontological status similar to the maximum of the light speed in the Special Theory of Relativity.

Detector and receiver of the photon exist in space only not in time

Time is not dimension of space, time is not a distance; time is the numerical order of photon motion in space. Interpretation of photon motion into space and time leads to the wrong conclusions, namely of existence of the “past detector” and “future detector”. Experimental data confirm detectors exist exclusively in space (16).

Conclusions

This article shows that in using a model of Minkowski 4D space where time t is exclusively a numerical order of material change it is possible to describe physical world more accurately. We live in a universe where measurable time as measured by clocks exists exclusively as a numerical order of material changes. Fundamental unit of numerical order Planck time t_p is derived from the light speed.

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