

# Interrelatedness of Space and Time

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## Abstract

Experimental data confirm material change i.e. motion run in space. There is no experimental evidence time being part of the space. Time is what we measure with clocks. With clocks we measure numerical order  $t_0, t_1, t_2 \dots t_n$  of material change. Material change  $n$  is followed by material change  $n+1$ , material change  $n+1$  is followed by material change  $n+2$  and so on. Material change  $n+1$  s “after” material change  $n$  equivalently as natural number 2 is “after” natural number 1. Numerical order  $t_0, t_1, t_2 \dots t_n$  of material change runs in a space only and not in time. There is no time existing behind numerical order of material change. In space “past”, “present” and “future” exist only as a numerical order of material change. Fundamental unit of numerical order  $t_0, t_1, t_2 \dots t_n$  of material change is a Planck time  $t_p$ . According to the formalism  $X_4 = i * c * t_n$  time  $t_n$  is only a component of  $X_4$  that we obtain with clocks.  $X_4$  is spatial too. Space is not 3D + T. Space is 4D.

**Key words:** space, time, space-time, numerical order of material change, run of clocks

## Introduction

Let's take photon moving from on the distance  $d$  between point A and point B of space. Distance  $d$  is composed out of Planck distances  $l_p$ :  $d = \sum l_{p1} + l_{p2} \dots + l_{pn}$ . The smallest distance photon can do on the way from A to B is  $l_p$ . Numerical order of motion from  $l_{p1}$  to  $l_{p2}$  is a Planck time  $t_p$ . Photon is moving exclusively in space and not in time. In space “before” and “after” exist only as a numerical order  $t_0, t_1, t_2 \dots t_n$  of a physical event:  $t_{n-1}$  is “before”  $t_n$  equivalently to natural number  $n-1$  is “before” natural number  $n$ . Numerical order of material change we measure with “ticking” of a clock where  $t_0$  represents beginning of the measurement,  $t_n$  end of the measurement.

Velocity  $v$  of a material change is derived from its numerical order  $t_n$ :  $v = \frac{d}{t_n} ms^{-1}$ .

Frequency  $\gamma$  of material change is derived from its numerical order  $t_n$ :  $\gamma = \frac{1}{t_n} s^{-1}$ .

In Special Theory of Relativity forth coordinate  $X_4$  of space is spatial too.  $X_4$  is a product of imaginary number  $i$ , light speed  $c$  and numerical order  $t_n$  of an event:  $X_4 = i * c * t_n$ . It is more correct to imagine cosmic space as a four-dimensional 4D space than 3D + T where fourth dimension is time. Time is numerical order of material change that we measure with clocks. Fundamental unit of numerical order  $t_0, t_1, t_2 \dots t_n$  of material change that run 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 a Planck distance. Planck time  $t_p$  exists in the universe as a fundamental physical unit that governs numerical order of material change.

## **Space is space and time is time**

In paper "Time and Classical and Quantum Mechanics: Indeterminacy Versus Discontinuity" Lynds discuss 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" (1).

In this paper is shown difference between space and time is following: time is a numerical  $t_0, t_1, t_2 \dots t_n$  order of material change that runs in space. According to the formalism  $X_4 = i * c * t_n$  time  $t_n$  is only a component of  $X_4$  that we obtain with clocks.  $X_4$  is spatial too. Space is not 3D + T. Space is 4D.

## **Time as Fundamental Arena can be eliminated**

In paper "The Mathematical Role of Time and Space-Time in Classical Physics" Newton C. A. da Costa and Adonai S. Sant'Anna shows that time as fundamental physical arena in which material change run 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" (2).

In this paper is shown that mathematical time  $t_n$  is numerical order of material change we measure with clocks. Fundamental arena in which material change runs is space. Time is merely a numerical order of material change.

## **"Killing time" is not necessary**

In paper "Killing time" James F. Woodward discuss 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 timelessness, can be established is mentioned" (3).

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

Recent neurological research shows we experience flow of numerical order of material change that run in timeless 4D space through psychological time "past-present-future". Consequent temporal experience of material change "one after other in time" is result of neuronal activity of the brain. In physical reality "one after other" exists only in a sense of

numerical order of material change.

“Traditionally, the way in which time is perceived, represented and estimated has been explained using a pacemaker–accumulator model that is not only straightforward, but also surprisingly powerful in explaining behavioural and biological data. However, recent advances have challenged this traditional view. It is now proposed that the brain represents time in a distributed manner and tells the time by detecting the coincidental activation of different neural populations (4).

### **Time as numerical order of material change resolves Zeno Problems on motion**

Zeno problems of motion confronted in terms of space and time are agitating human reason for centuries. Here we see that motion exists in space only and not in time. With clocks we measure numerical order of motion. Achilles surpasses Tortoise in space only and not in time. Velocity  $v$  of both runners is derived from the numerical order of their motion. You imagine Achilles at the point  $A$ , Tortoise at the point  $T$ . Between  $A$  and  $T$  there is a distance  $d$ . When they start running into the same direction we activate a stopwatch. When Achilles is surpassing Tortoise we stop stopwatch. On the stopwatch we see  $t_n = 10 \text{ sec}$ . Achilles has passed 10 meters, his speed is  $v = 1 \text{ ms}^{-1}$ . Tortoise has passed 1 meter, its  $t_n = 10 \text{ sec}$ , velocity is  $v = 0,1 \text{ ms}^{-1}$ . At the starting points the distance  $d$  between Achilles and Tortoise was 9 meters. Achilles runs distance  $d_1 = 10 \text{ m}$ . Tortoise runs distance  $d_2 = 9 \text{ m}$ . They both move in space only and not in time. Clock is a measuring device for numerical order  $t_0, t_1, t_2 \dots t_n$  of their motion. Their velocities  $v_a = \frac{d_1}{t_n}$  and

$v_t = \frac{d_2}{t_n}$  are derived from numerical order of their motion.

### **Conclusions**

Time is what we measure with clocks: numerical order of material change running in space. Physical past, present and future exist in space as a numerical order of material change which run in space. Time  $t$  we obtain with clocks is only a component of fourth coordinate  $X_4 = i * c * t$ . Space is 4D. We experience numerical order of material change in 4D space through psychological time “past-present-future” which is result of neuronal activity of the brain. This view on time resolves Zeno problem on motion, hypothetical time travel into past and opens new perspectives into deeper understanding of the universe on macro and macro level.

In this article is shown that without using concept of time as a forth dimension of space-time one can describe physical world more accurately; in the universe nothing can happen in “past-present-future” that is merely a psychological frame into which we experience material change running in space. In physics symbol  $t$  has only mathematical value; it describes numerical order of material change running in a timeless space.

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