Time is Numerical Order of Material Change

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Abstract

Going deeper into the measurement of time we see that with clocks we measure numerical order $t_0, t_1, t_2 ... t_n$ 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 $t_0, t_1, t_2 ... t_n$ 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 $t_0, t_1, t_2 ... t_n$ of material change is a Planck time t_p.

Key words: 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: $d = \sum l_{p1} + l_{p2} ... + l_{pn}$. 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 $t_0, t_1, t_2 ... t_n$ 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 γ 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 $t_0, t_1, t_2 ... t_n$ 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. One can travel in space only and not in time. Hypothetical time travels into past are out of question.

Time t is only a component of fourth dimension X4 of space

Here time is given right definition according to our perception: material change runs in space only and not in time. Time is numerical order of material change and is measured with a clock. Material change runs in $4D$ space. In a given equation $X_4 = i * c * t$ meaning of symbol t is numerical order t_n of material change obtained with a clock. Time t obtained with clocks is only a component of fourth dimension X4 of space.

Some of researchers are challenged with the view that space-time is the fundamental arena of the universe. They point out that the mathematical model of space-time does not correspond to physical reality, and propose a "state space" or a "timeless space".

For example, in *A New Geometric Framework for the Foundations of Quantum Theory and the Role Played by Gravity*, Palmer underlines that, since quantum theory is inherently blind to the existence of state-space geometries, attempts to formulate unified theories of physics within a conventional quantum-theoretic framework are misguided, and that a successful quantum theory of gravity should unify the causal non-Euclidean geometry of space-time with the a-temporal fractal geometry of state space (1). In this paper, Palmer introduces a new geometric law of physics about the nature of physical reality based on an Invariant Set Postulate. The Invariant Set Postulate conjectures that states of physical reality are defined by a fractal geometry *I* , embedded in state space and invariant under the action of some subordinate causal dynamics D_I . The postulate is motivated by two concepts that would not have been known to the founding fathers of quantum theory: the generic existence of invariant fractal subsets of state space for certain nonlinear dynamical systems, and the notion that the irreversible laws of thermodynamics are fundamental rather than phenomenological in describing the physics of extreme gravitational systems. The Invariant Set Postulate posits the existence of a fractionally-dimensioned subset *I* of the state space of the physical world (namely the universe as a whole). *I* is an invariant set for some presumed-causal (namely relativistic) deterministic dynamical system D_I ; points on *I*, called also "world states", remain on *I* under the action of D_I . World states of physical reality are those, and only those, lying precisely on *I*. It is important to underline that in Palmer's theory, the subset *I* of the state space is more primitive than the deterministic dynamical system D_I . Given *I*, $D_I(t)$ maps some point $p \in I$, a parameter distance *t* along a trajectory of *I*. Crucially, D_I is undefined at points $\notin I$: if states of physical reality necessarily lie on *I*, then points $p \notin I$ in state space are to be considered literally "unreal". For practically-relevant theories (such as quantum theory) the intricate structure of *I* is unknown and these points of unreality cannot be ignored. As regards the key question of how to represent quantum-theoretic states in a mathematically-consistent way for such points of unreality, the Invariant Set Postulate provides support to the search for a timeless description of physics: by treating the geometry of the invariant set as primitive introduces a fundamentally timeless perspective into the formulation of basic physics.

Clocks as a measuring system of numerical order $t_0, t_1, t_2 ... t_n$ can be considered the most direct and natural development of Palmer's approach: it is a description of motion in physics where velocity v of a physical event is derived from its numerical order t_n : $v = \frac{d}{t_n} ms^{-1}$.

Girelli, Liberati and Sindoni have recently developed a toy model in which they have showed how the Lorentzian signature and a dynamical space-time can emerge from a non-dynamical Euclidean space, with no diffeomorphisms invariance built in. In this sense this toy-model provides an example where time (from the geometric perspective) is not fundamental, but simply an emerging feature (2). In more detail, this model suggests that at the basis of the arena of the universe there is some type of "condensation", so that the condensate is described by a manifold R^4 equipped with the Euclidean metric $\delta^{\mu\nu}$. Both the condensate and the fundamental theory are timeless. The condensate is characterized by a set of scalar fields $\Psi_i(x_\mu)$, i=1,2,3. Their emerging Lagrangian L is invariant under the Euclidean Poincarè group ISO(4) and has thus the general shape

L = F(X1;X2;X3) = f(X1) + f(X2) + f(X3); $X_i = \delta^{\mu\nu}\partial_\mu\Psi_i\partial_\nu\Psi_i$ (1).

The equations of motion for the fields $\Psi_i(x_\mu)$ are simply given by

$$\partial_\mu\left(\frac{\partial F}{\partial X_i}\partial^\mu\Psi_i\right) = 0 = \sum_j\left(\frac{\partial^2 F}{\partial X_i \partial X_j}\left(\partial^\mu X_j\right) + \frac{\partial F}{\partial X_i}\partial_\mu\partial^\mu\Psi_i\right) \quad (2)$$

The fields $\Psi_i(x_\mu)$ can be expressed as $\Psi_i = \psi_i + \varphi_i$ where φ_i are the perturbations around the solutions ψ_i of the above equation. The lagrangian for ψ_i is given by

$$F(\bar{X}_1, \bar{X}_2, \bar{X}_3) + \sum_j \frac{\partial F}{\partial X_j}(\bar{X})\delta X_j + \frac{1}{2}\sum_{jk}\frac{\partial^2 F}{\partial X_j \partial X_k}(\bar{X})\delta X_j \delta X_k + \frac{1}{6}\sum_{jkl}\frac{\partial^3 F}{\partial X_j \partial X_k \partial X_l}(\bar{X})\delta X_j \delta X_k \delta X_l$$

(3)

where $\bar{X}_i = \delta^{\mu\nu}\partial_\mu\psi_i\partial_\nu\psi_i$ and $\delta X_i = 2\delta_\mu\psi_i\partial^\mu\psi_i\partial_\mu\varphi_i\partial^\mu\varphi_i$.

Different choices of the solutions ψ_i lead to different metrics

$$g_k^{\mu\nu} = \frac{df}{dX_k}(\bar{X}_k)\delta^{\mu\nu} + \frac{1}{2}\frac{d^2 f}{(dX_k)^2}(X_k)\partial^\mu\psi_k\partial^\nu\psi_k \quad (4).$$

If one considers the specific class of equations of motion for which $\psi_i = \alpha^\mu x_\mu + \beta$, the SO(4) symmetry leads to $\bar{\psi} = \alpha x_0 + \beta$ which shows that the choice of the coordinate is completely arbitrary. Hence the Lorentzian signature can be obtained for the condition $\frac{df}{dX}(\bar{X}) + \frac{\alpha^2}{2}\frac{d^2 f}{(dX)^2}(\bar{X}) < 0$, $\frac{df}{dX}(\bar{X}) > 0$ and in this case the lagrangian becomes $L_{eff} = \sum_i \eta^{\mu\nu}\partial_\mu\varphi_i\partial_\nu\varphi_i$ where $\eta^{\mu\nu}$ is the Minkowski metric. Moreover, Girelli, Liberati and Sindoni have showed that by means of the change of variables

$$\begin{pmatrix}\varphi_1\\ \varphi_2\\ \varphi_3\end{pmatrix} = \Phi\begin{pmatrix}\phi_1\\ \phi_2\\ \phi_3\end{pmatrix} \quad (5)$$

with $\Phi^2 = \sum_i \phi_i^2 = l^2$ where l is related to Planck scale, a dynamical space-time emerges from L_{eff}, which is characterized by the Einstein-Fokker equations

$R = 2\pi G_N T$ (6),

$C_{\alpha\beta\gamma\delta} = 0$ (7)

where

$R = \frac{6}{l^2} T$ (8),

$T(\phi_i) = g^{\mu\nu} T_{\mu\nu}(\phi_i) = -\Phi^2 \sum_i \eta^{\mu\nu} \partial_\mu \phi_i \partial_\nu \phi_i$ (9),

$g_{\mu\nu} = \Phi^2(x) \eta_{\mu\nu}$ (10)

(which shows that the gravitational degree of freedom is encoded in the scalar field Φ) and where G_N is proportional to l^{-2}.

The toy model developed by Girelli, Liberati and Sindoni shows in a clear way that time cannot be considered a fundamental reality, at a fundamental level space is timeless: the picture of the universe provided by this model is a mathematical proof of the idea that numerical order of change runs in a space only and not in time.

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 $t_n = 10 \sec$. Achilles has passed 10 meters, his speed is $v = 1 ms^{-1}$. Tortoise has passed 1 meter, its $t_n = 10 \sec$, velocity is $v = 0{,}1 ms^{-1}$. At the starting points the distance d between Achilles and Tortoise was 9 meters. Achilles runs distance $d_1 = 10\, m$ .Tortoise runs distance $d_2 = 9 m$ .They both move in space only and not in time. Clock is a measuring device for numerical order $t_0, t_1, t_2 ... t_n$ 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.

Numerical order of material change experienced through psychological time creates experience in “past-present-future”

Recent neurological research shows we experience flow of numerical order of material change that run in space through psychological time “past-present-future”. Consequent 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 (3).

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. Time t we obtain with clocks is only a component of fourth coordinate $X_4 = i * c * t$. We experience numerical order of material change in 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.

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