

Time as the result of observer's measurement

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Abstract

Since the beginning of physics time is the duration of material changes. We measure time with clocks. The notion of time in Newton physics, Einstein's relativity and quantum physics are different despite we always measure the same time with the same apparatuses that are clocks. We showed in this article that the act of the measurement done by the observer is generating duration. Time as duration is the result of the interaction between the observer and physical reality via clocks. In the universe, only changes exist. Changes have no duration on their own. Time as duration is born with the measurement done by the observer.

Keywords: time, change, clock, entanglement, gravity, observer.

1. Introduction

Rovelli is saying that time is an illusion. "According to theoretical physicist Carlo Rovelli, time is an illusion: Our naive perception of its flow doesn't correspond to physical reality. Indeed, as Rovelli argues in *The Order of Time*, much more is illusory, including Isaac Newton's picture of a universally ticking clock. Even Albert Einstein's relativistic space-time — an elastic manifold that contorts so that local times differ depending on one's relative speed or proximity to a mass — is just an effective simplification" [1].

Our research confirms that the relative velocity of material changes depends on the variable energy density of superfluid quantum space including the relative rate of clocks [2]. Superfluid quantum space is time-invariant in the sense that time as duration has no impact on the superfluid quantum space's physical properties nor it is part of its constitution [3]. Time as duration and space as the superfluid quantum space in which changes run are happily divorced after forced marriage back in 1905.

2. Bijective model of time and entanglement

In bijective modelling, every element in the model has exactly one correspondent model in physical reality. Superfluid quantum space is time-invariant and is the carrier of the entanglement EPR-type. All physical objects in the universe are entangled via superfluid quantum space (SQS). Information transfer in SQS passes via higher-dimensional spatial layers (5 and more) and is immediate. Photon is the excitation of SQS 4th dimensional layer and carries information with the light speed. Time is the duration of photon motion from object A to object B on the given distance in SQS. In bijective physics universal space is time-invariant and time is the duration of changes, i.e., motion in space when measured by the observer. The paradigm shift is that without measurement we have only motion in time-invariant space.

In this bijective model of physical reality time as duration cannot be the manifestation of entanglement as suggested by recent research: "This work shows that there is not a "quantum time", possibly opposed to a "classical" one; there is only one time, and it is a manifestation of entanglement [4]. The statement that time is the manifestation of entanglement is not falsifiable and despite all the mathematical support that article is providing there is no single experimental data that this statement is right.

Mathematics is the useful tool of physics only if the model is falsifiable. Mathematics is a useful tool of physics only if the model is falsifiable. Mathematics in the model that is not falsifiable has no real meaning and is no real proof that the model is an adequate picture of physical reality. The model that is bijective is automatically also falsifiable. In bijective physics, the model and physical reality are related by the bijective function of set theory. Physical reality is set X and model of physical reality is set Y. Every element in set X has exactly one correspondent element in the set Y.

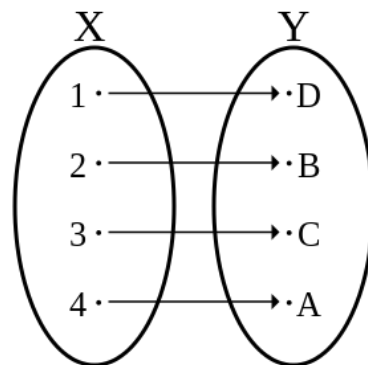


Figure 1: Bijective modelling in physics

In bijective physics, entanglement is the function of the superfluid quantum space and the duration of the entanglement is zero. Time as duration cannot be a manifestation of entanglement. Time as duration is the manifestation of measurement.

In bijective physics, time as the duration of the model of reality (set Y) has bijective correspondence with the time in physical reality (set X):

$$f: t_X \rightarrow t_Y \quad (1).$$

The model of superfluid quantum space has bijective correspondence with the physical superfluid quantum space:

$$f: SQS_X \rightarrow SQS_Y \quad (2).$$

We do not observe time as a physical quantity that runs in the entire universal space, we do not observe time as the 4th dimension of space, we only observe material change, i.e., motion in space. The hypothetical proposition that time runs as some physical quantity in the universe and that changes run in this time should be abandoned in the name of physics progress. Also, the hypothetical proposition that time is the 4th dimension of space and that changes run in space-time as a fundamental arena of the universe should be abandoned in the name of physics progress. Our model of time is confirming the quantum mechanics (QM) model of time where time is not recognizable as an observable: “The notion of time is deeply rooted into our perception of reality, which is why, for centuries, time has entered Physics as a fundamental ingredient that is not to be questioned. Then, general relativity (GR) and quantum mechanics (QM) intervened in opposite directions: GR gave time the same status of position, while QM made time a parameter, external to the theory and not recognizable as an observable” [4]. We went further, namely, time not only is not observable, but time in the universe does not exist. Time is the result of the measurement.

What exists in the universe is the numerical order of material changes, i.e., motion. The fundamental unit of the numerical order is Planck time. Photon for example is passing one Planck distance in one Planck time. The duration of photon motion between two points A and B in SQS is the sum of Planck times:

$$t = t_{p1} + t_{p2} + \dots + t_{pN} = \sum_{i=1}^N t_{pi} \quad (3) [5].$$

We observe in the universe that the irreversible stream of changes has its numerical order. When change X+1 enters existence, change X is not in existence anymore. When change X+2 enters existence, change X+1 is not in existence anymore. Changes run in SQS which is time-invariant. Time as duration enters existence when we measure the numerical order of changes. Every elapsed time is the sum of Planck times and can be dissected in Planck times. When

Planck time $X+1$ enters existence, Planck time X is not in existence anymore. When Planck time $X+2$ enters existence, Planck time $X+1$ is not in existence anymore. In this perspective, the numerical order of universal changes run in time-invariant SQS that is the medium of entanglement. In bijective physics, entanglement EPR-type in the model (set Y) has bijective correspondence with the entanglement EPR-type in physical reality (set X).

$$f: \text{entanglement}_X \rightarrow \text{entanglement}_Y \quad (4).$$

Entanglement is carried by the time-invariant SQS. One could say that entanglement is the manifestation of the time-invariant nature of SQS. This is far away from the idea that time as duration is the manifestation of entanglement.

The relative rate of clocks depends on the variable energy density of SQS: "For example, when one second has passed on the Earth surface, at the point T in infinity 1.000000000695915 second has passed. Elapsed time at a point 20 km above the Earth's surface comparing with the 1 second elapsed time on the Earth's surface is 1.0000000000218 second. Elapsed time at a point 40 km above the Earth's surface comparing with the 1 second elapsed time on the Earth's surface is 1.0000000000434 second. The elapsed time at the surface of a black hole with the mass of the Sun and radius of 3000 metres compared with the elapsed time of one second on the Earth surface is 0.12486696822 second. The rate of clocks is increasing with the increasing of the SQS energy density and the rate of clocks is diminishing with the diminishing of the SQS energy density" [2].

3. Page and Wootters (PaW) mechanism is not bijective and so not falsifiable

Time as the manifestation of entanglement is based on Page and Wootters (PaW) mechanism that is based on three assumptions: "(i) the clock does not interact with the system to which it provides the parameter t , but (ii) it is entangled with it; moreover, (iii) clock and system together are in an eigenstate of the total Hamiltonian (with eigenvalue that can be set equal to zero, for the sake of simplicity and without loss of generality). The PaW mechanism has been extensively used, and its assumptions scrutinized, in the recent literature, both from the theoretical and the experimental viewpoint" [4]. Our comments are the following: (i) the clock interacts with the system via the observer. In the PaW mechanism there is no observer, this is its weak point. (ii) the clock is not entangled with the system. Here term "entanglement" is misinterpreted. We know in physics what the term "entangled" means and we know has nothing to do with the clock and the system. (iii) clock and system together cannot be seen as an eigenstate of the total Hamiltonian that is used on the quantum level. A quantum system prepared in an eigenstate of the Hamiltonian has time-invariant probability density. Time-

invariant probability density means "immediate" which is characteristic of the entanglement. PaW mechanism is not falsifiable and as such has no scientific validity.

Moreva and coauthors are proposing an experiment that should confirm the validity of PaW mechanism, they introduce the existence of the "super-observer": " Although extremely simple, our model captures the two, seemingly contradictory, properties of the PaW mechanism: the evolution of the subsystems relative to each other, and the staticity of the global system. This is achieved by running the experiment in two different modes (see Fig. 2a): (1) an "observer" mode, where the experimenter uses the readings of the clock photon to gauge the evolution of the other: by measuring the clock photon polarization he becomes correlated with the subsystems and can determine their evolution. This mode describes the conventional observers in the PaW mechanism: they are, themselves, subsystems of the universe and become entangled with the clock systems so that they see an evolving universe; (2) a "super-observer" mode, where he carefully avoids measuring the properties of the subsystems of the entangled state, but only global properties: he can then determine that the global system is static. This mode describes what an (hypothetical) observer external to the universe would see by measuring global properties of the state $|\Psi_i\rangle$: such an observer has access to abstract coordinate time (namely, in our experimental implementation he can measure the thickness of the plates) and he can prove that the global state is static, as it will not evolve even when the thickness of the plates is varied" [6]. In this article "super-observer" is defined as an "external observer to the universe". And he would be able to access "abstract coordinate time". The term "super-observer" is not falsifiable, the term "abstract coordinate time" is not falsifiable. The common sense of physics is lost.

Despite mathematics that is used in reference [4] and reference [6] as the support to prove that time is the manifestation of entanglement based on PaW mechanism, we show that there is no common-sense logic in it. Common-sense logic is based on the bijectivity where every element in the model has exactly one correspondent model in physical reality. Mathematics in references [4] and [6] is right, but as most of the elements in the equations have only mathematical existence and have no direct correspondence with the physical world, the result is false: time is the manifestation of entanglement. Moreover, the term "manifestation" is not a common term in physics. This term belongs to philosophy. In physics, phenomenon A cannot "manifest" phenomenon B. Phenomenon A can transform in phenomenon B as it is expressed in famous $E = mc^2$. The right part of the mass-energy equivalence equation is following:

$$E = mc^2 = (\rho_{EP} - \rho_{Emin})V \quad (5),$$

where ρ_{EP} is Planck energy density of SQS in interstellar space, ρ_{Emin} is SQS energy density in the centre of given physical object, and V is the volume of the physical object. Variable energy density of SQS is carrying gravity [3]. Several authors are proposing that entanglement is induced by gravity [7,8,9]. Their ideas are not falsifiable. Taking into account the proposal that time is the result of entanglement [4,6] we can come to the idea that time is the manifestation of gravity. All this seems does not make sense and no progress. Physics needs to turn back and rediscover Karl Popper's work.

4. Conclusions

Interpretation of time is a manifestation of entanglement has no single data that would support this idea. Bijective research methodology is assuring bijectivity and clearly showing the only time that exists is the duration. “Time is duration” fits Newton's physics, Relativity, and quantum physics. Time is the result of measurement done by the observer. Clocks without being seen by the observer are not measuring time, they are ticking in the time-invariant superfluid quantum space. It is the observer’s act of measurement that is creating time.

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