

## Time as the result of the 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. Duration is relative and depends on the variable energy density of time-invariant superfluid quantum space that is the carrier of EPR-type entanglement. © 2021 Physics Essays Publication.

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**Résumé:** Depuis le début de la physique, le temps est la durée des changements matériels. Nous mesurons le temps avec des horloges. La notion de temps dans la physique de Newton, la relativité d'Einstein et la physique quantique sont différentes bien que nous mesurons toujours le même temps avec les mêmes appareils que sont les horloges. Nous avons montré dans cet article que l'acte de mesure effectué par l'observateur est générateur de durée. Le temps comme durée est le résultat de l'interaction entre l'observateur et la réalité physique via des horloges. Dans l'univers, seuls les changements existent. Les modifications n'ont pas de durée en elles-mêmes. Le temps comme durée naît avec la mesure faite par l'observateur. La durée est relative et dépend de la densité d'énergie variable de l'espace quantique superfluide invariant dans le temps qui est porteur de l'intrication de type EPR.

Key words: Time; Change; Clock; Entanglement; Gravity; Observer.

### I. 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.”<sup>1</sup>

Our research confirms that the relative velocity of material changes depends on the variable energy density of superfluid quantum space (SQS) including the relative rate of clocks.<sup>2</sup> SQS is time-invariant in the sense that time as duration has no impact on the SQS's physical properties nor it is part of its constitution.<sup>3</sup> In this article, we show that the space-time model has no physical reality. Time and space are two different phenomena.

### II. BIJECTIVE MODEL OF TIME, ENTANGLEMENT, AND GRAVITY

In bijective modeling, every element in the model has exactly one correspondent model in physical reality. SQS is time-invariant and is the carrier of the entanglement EPR-

type. All physical objects in the universe are entangled via SQS. Information transfer in SQS passes via higher-dimensional spatial layers (five and more) and is immediate. Photon is the excitation of SQS fourth 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 and 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.”<sup>4</sup> 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 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, see Fig. 1.

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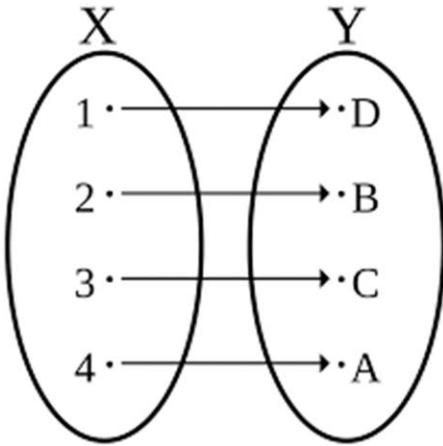


FIG. 1. Bijective modeling in physics.

In bijective physics, entanglement is the function of the SQS, 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)

$$f : t_x \rightarrow t_y. \tag{1}$$

The model of SQS has bijective correspondence with the physical SQS

$$f : SQS_X \rightarrow SQS_Y. \tag{2}$$

We do not observe time as a physical quantity that runs in the entire universal space, we do not observe time as the fourth dimension of space, and 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 change run in this time should be abandoned in the name of physics progress. Also, the hypothetical proposition that time is the fourth 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 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.”<sup>4</sup> 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<sup>5</sup>

$$t = t_{p1} + t_{p2} + \dots + t_{pN} = \sum_{i=1}^N t_{pi} \tag{3}$$

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 runs 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).

$$f : \text{entanglement}_X \rightarrow \text{entanglement}_Y. \tag{4}$$

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 1.00000000000434 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.”<sup>2</sup>

Formula  $E = mc^2$  is expressing the relation between the amount of matter (mass) and the energy of a given physical object. We extended the mass-energy equivalence equation as follows:

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

where  $\rho_{EP}$  is Planck energy density of SQS in interstellar space,  $\rho_{Emin}$  is SQS energy in the center of given physical object, and  $V$  is the volume of the physical object. Variable energy density of SQS is carrying gravity.<sup>3</sup> Several authors are proposing that entanglement is induced by gravity.<sup>6-8</sup> Their ideas are not falsifiable. Taking into account the proposal that time is the result of entanglement,<sup>4,9</sup> one 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 and his

falsifiability test that is the demarcation line between science and pseudoscience.<sup>10</sup>

### III. PAGE AND WOOTTERS (PAW) MECHANISM IS NOT BIJECTIVE AND SO NOT FALSIFIABLE

The bijectivity test of a given scientific model that we introduce in this article directly assures falsifiability. Bijectivity and falsifiability both have their basis in elementary perception and experience. We will show in this captures that Page and Wootters (PaW) mechanism belongs to pseudoscience, because they predict the existence of phenomena that are not observable and so not experienceable.

Time as the manifestation of entanglement is based on the 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.”<sup>4</sup>

Our comments are the following:

- (i) The clock interacts with the system via the observer. In the Paw mechanism, there is no observer, and this is its weak point. Without the observer, physics could not exist.
- (ii) The clock is not entangled with the system. The term “entanglement” is here misinterpreted. We know in physics what term “entangled” means in the EPR-type experiment means and we know entanglement 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. Clock and system are not entangled as two elementary particles in the EPR-type experiment.

Our analysis is confirming the PaW mechanism is not bijective and so not falsifiable and as such has no scientific validity, it belongs to pseudoscience.

Moreva and coauthors are proposing an experiment that should confirm the validity of PaW mechanism, and they introduce the existence of the “superobserver”: “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.”<sup>9</sup> In this article, “superobserver” is defined as an “external observer to the universe.” And he would be able to access “abstract coordinate time.” The term superobserver is not bijective and so not falsifiable, the term “abstract coordinate time” is not bijective and so not falsifiable. The common sense of physics is here lost, and this is more philosophy of physics than real physics. Real physics is based on observation, experiment, and bijectivity that assures falsifiability.

Despite mathematics that is used in Refs. 4 and 9, 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 Refs. 4 and 9 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.

### IV. OBSERVER’S ACT OF MEASUREMENT IS CREATING DURATION

We know in QM that electrons when behaving as waves, they can simultaneously pass through several openings in a barrier and then meet again at the other side of the barrier. This is known as “interference.” Article published in Nature is confirming that interference can only occur when no one is watching. Once an observer begins to watch the particles going through the openings, the picture changes dramatically: if a particle can be seen going through one opening, then it is clear it did not go through another. This confirms when under observation, electrons behave like particles and not like waves.<sup>11</sup>

The result of Ref. 11 proves that the observer is an integrative part of QM physics. In the case of time existence, this is valid also on the macro level. No material change, i.e., motion, has a duration on its own. The duration enters existence when being measured by the observer. Otherwise, only material change, i.e., motion, exists. They run in a universal space that is time-invariant in the universal space there is no trace of time.<sup>3,5</sup> Linear time “past–present–future” runs only in the observer’s mind and has exclusively psychological

existence. Psychological logical time has its physical origin in the neuronal activity of the brain.<sup>12</sup> When measurement with clocks occurs, the psychological time creates its physical manifestation, the duration, that otherwise has no physical existence. This fact is of immense importance for physics progress.

Our research results are suggesting that in the physical universe there is no symmetry in time because time has no physical existence. Physical phenomena can only be in symmetry in the time-invariant universal space that has physical existence.<sup>13</sup> In this perspective, time travels into the past or future are out of the question. One can travel only in time-invariant universal space.

## V. 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, and they are ticking in the time-invariant SQS. It is the observer’s act of measurement that is creating time as the duration.

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