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The "Twin Paradox" is no paradox according to the law of Self variations

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Abstract*— Understanding the arrow of time as an element of physical reality in the macrocosm is a lasting issue of the scientific community. The theory of relativity gave us important information for space-time itself, but not for the arrow of time in the macrocosm. The "twin's paradox" is the most prominent Gedanken experiment that relates the theory of relativity with the arrow of time. Considering only the time flow difference for each of the twins, the theory of relativity concludes that the twins may have different age, under the conditions of the known Gedanken experiment. The age difference can have any value, depending on the movement performed by one of the twins, making a trip into space and back to Earth. Given the law of Self variations, we arrive at the opposite conclusion. Despite the different flow of time for each one, no one will be elder than the other.

***Index Terms*— Arrow of time, Twin paradox, Self variations.**

I. INTRODUCTION

The law of Self variations contains the arrow of time in the macrocosm [1].The increase of the rest masses of material particles and the electric charge of matter with the passage of time, "displaces" the universe from the original "vacuum state" to the form we observe today. In the microcosm of the law predicts that there is no arrow of time. We can not deal with t in this issue in the current article. But we will see that if we take into account the law of Self variations, no one of the twins will be elder than the other, in the famous "twins paradox".

The law of Self variations for the rest mass m_0 is given [2] in the macrocosm by the equations:

$$\frac{\partial m_0}{\partial t} = -\frac{b}{\hbar}\frac{E_0 m_0}{\sqrt{1-\frac{u^2}{c^2}}}, \qquad (1)$$

$$\nabla m_0 = \frac{b}{\hbar}\frac{E_0 m_0}{c^2\sqrt{1-\frac{u^2}{c^2}}}\mathbf{u}, \qquad (2)$$

where $b \neq 0$ is an arbitrary constant, $\hbar$ is the reduced Planck's constant, $\hbar = \frac{h}{2\pi}$, $\frac{E_0}{c^2}$ is the rest mass of the accompanying particle, $\mathbf{u}$ is the velocity of the material particle, t is time and $\nabla = \left(\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z}\right)$ in an inertial reference frame $S(x,y,z,t)$. The variation dm_0 of the rest mass m_0 of the material particle is

$$dm_0 = \frac{\partial m_0}{\partial t}dt + d\mathbf{r}\cdot\nabla m_0,$$

where $d\mathbf{r} = \mathbf{u}dt$ is the displacement of the particle, hence from equations (1) and (2) we have:

$$dm_0 = -\frac{b}{\hbar}\frac{E_0 m_0}{\sqrt{1-\frac{u^2}{c^2}}}\left(1-\frac{u^2}{c^2}\right)dt \qquad (3)$$

$$dm_0 = -\frac{b}{\hbar}E_0 m_0\sqrt{1-\frac{u^2}{c^2}}dt.$$

For the 4-dimensional arc length dS we have

$$dS^2 = (cdt)^2 - (d\mathbf{r})^2$$

$$dS^2 = c^2(dt)^2 - (\mathbf{u}dt)^2$$

$$dS^2 = (c^2 - u^2)(dt)^2$$

$$dS^2 = \left(1-\frac{u^2}{c^2}\right)c^2(dt)^2$$

$$dS^2 = \sqrt{1-\frac{u^2}{c^2}}cdt. \qquad (4)$$

Combining equations (3) and (4) we get equation (5)

$$dm_0 = -\frac{b}{\hbar}E_0 m_0\,\mathrm{dS}. \qquad (5)$$

Analogous with (5) is also the equation which gives the variation dq of the electric charge q in the case the material particle has an electric charge. All physical quantities in the right side of equation (5) are invariant for all inertial reference frames and thus the variation dm_0 (and the variation dq) are the same for all inertial reference frames. In case the material particle performs a random, accelerated motion, it passes successively through many inertial reference frames. Thus, the variations dm_0 and dq are the same for all

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inertial reference frames. We coma to the same conclusion if we go from a local inertial reference frames $S(x, y, z, \mathrm{t})$ to a non- inertial reference frames.

We consider two material particles with the same rest mass m_0 and electric charge q at the same point $A(x, y, z, t_1)$ of spacetime. The first remains on the point $A(x, y, z)$, while the second performs a random movement and returns to $A(x, y, z)$. According to equation (5) when the two material particles will arrive at $A(x, y, z, t_2)$ they will have equal rest masses and electric charges.

II. THE TWIN PARADOX AND THE LAW OF SELFVARIATIONS

We consider two twin brothers, the first remains on Earth, while the second makes a journey in space, performs a random motion and returns to earth. The first of the twins counts a travel time interval T_1 for the duration of the journey, while the second counts a travel time T_2. The equations of relativity give that

$T_2 < T_1$. (6)

The resulting difference in the travel time of the journey, is known as the "twins paradox" [3] - [5].

For those that are not familiar with the theory of relativity we note that if the first twins counts a travel time $T_1 = 50\, years$, then the second one will notice too that the earth will have done 50 revolutions around the sun. The difference between the periods T_1 and T_2 results from the difference in the flow of time between the two observers and not from the events that have taken place during the journey. According to equation (6), and if we do not take into account the Self variations, the second twin is younger than the first upon his return to Earth. But if we include the Self variations, the conclusion is different.

The time interval on itself is not sufficient to determine the age of the twins. That would be correct only if there was no way to observe and precisely define the arrow of time in the macrocosm. The Self variations incorporate the arrow of time, as it is determined by the increase of the rest mass of material particles in the macrocosm. Watching the evolution of Self variations we find that after the completion of the journey the particles of matter in the cells of both twins are identical. They have undergone exactly the same change, the same evolution. If there was no evolution due to the Self variations, then the only way to compare the aging of the twins would be the travel time interval of the duration of the journey, for each twin. The aging is actually determined, not by the time elapsed, but by the evolution that took place in the cells of each twin.

As we have already noticed, the events that have taken place during the journey are the same for both twins and the difference in the performed measurements refers only to the space-time coordinates of the events. That is why it is referred to as the "twin's paradox". There was no strict definition of the arrow of time in the macrocosm, so that we can compare if there is a difference between the two twins. The law of Self variations determines exactly the arrow of time and according to equation (5) there is no difference whatsoever between the two twins for the evolution of the Self variations. The law of Self variations connects the Self variations with the quantum effects and the interactions of material particles.

We hope that the main article on this study will be published in 2015. We are making this reference here because the Self variations affect the totality of physical processes that happen in the microcosm. For this reason we expect that the development of the cells of the twins will be identical. The two twins will have undergone the same aging when they meet again on earth, after the end of the journey. The rest mass and absolute electric charge of the particles of matter increases with time in a way such that, after the end of the journey, the particles will be identical for both twins, with respect to the properties affected by the self variations.

According to the law of Self variations and equation (5), the arrow of time and the evolution of physical reality, does not depend on the reference frame chosen to describe it. In this sense there is no "twin's paradox" in the theory of Self variations. The "cosmic age", if we can say so, of the twins, as determined by the evolution of the Self variations, is identical.

III. CONCLUSION

The law of Self variations contains the arrow of time in the macrocosm. The universe evolves in a particular direction in the macrocosm. This evolution depends not only on time t, but on the 4-dimensional arc length dS. Consequently, this evolution is independent of the reference frame that we choose for its mathematical description. The Self variations are missing from the physical theories of the last century. Thus, when studying the “Twin Paradox”, these theories take into account only the time intervals T, resulting in a paradox.

IV. DISCUSSION

The understanding of time is always related to the arrow of time, which is present and comprehensible in the macrocosm. The theory of relativity gave us much important information about time, as the fourth dimension of space-time. We now know the relativity of simultaneity, the relationship between the energy content of space-time and the properties of space-time itself and that every observer has his own space-time. However it does not provide us with the main information about the arrow of time. This information is provided by the law of Self variations. A fundamental

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physical law that is missing from the physical theories of the last century.

The law of Self variations contains the arrow of time. The study presented above shows that the Self variations themselves do not depend on the reference frame we choose to study them. Moreover, the time duration of a natural process, is not sufficient to determine its evolution. The evolution of a natural process or a physical experiment is determined by the evolution of the Self variations. And this evolution is independent of the coordinate system we choose to study it. From the physical theories of the last century, it is apparent that the entropy of a system is the most suitable physical quantity for the study of the arrow of time. According to the Theory of Self variations (TSV) the time evolution of the Self variations determines the arrow of time.

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