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A MATHEMATICAL MODEL TO EXTEND THE THEORY OF RELATIVITY WHEN THE VELOCITIES OF THE MASS ARE LARGER THAN THE VELOCITY OF THE LIGHT c AND ITS POSSIBLE APPLICATION IN COSMOLOGY

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Abstract. In this paper we analyze the subject in the title accepting that the Mathematical model from the Theory of Relativity (RT) corresponding to the velocity $v < c$ is also valid to the case $v > c$. In the same time we apply the method to solve the equations of type $y^2 \pm \varphi = 0$ in their simplest form $y^2 \pm 1 = 0$ developed in [9] and [10]. Here we assign the "dual" solutions for $v < c$ and $v > c$ respectively and the "bipolar" solutions for the two forms of the Mass in the Universe called Matter (MA) and Antimatter (AM), respectively.

1. Introduction

In the first half of the last century it was elaborated and developed the Theory of Relativity (TR) [1] which together with the Quantum Mechanics, constitute the base of the important scientific progress registered presently in the domain of the phenomena happened in the Macrocosm and Microcosm.

It is well known the fact that in accordance with TR, for many important physical measures as Space, Time, Mass, Energy there exist different mathematical models then those applied to the Classical Physics, with its most important chapter of the Newtonian Mechanics.

The "revolutionary" idea introduced in the TR is that in the study of the physical phenomena, all of the important physical measures mentioned above are dependent of the velocity of the object in relation with the referring system in which it exists.

We continue to concentrate our attention on the Mass of the bodies reminding that in TR the formula which shows the dependency of the mass with the velocity is:

$$\frac{m}{m_0} = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{1}$$

where m is the mass of the body in motion with the velocity v, m_0 is the mass of the body at rest and c is the velocity of the light in vacuum ($c = 300,000\,km/s$). For simplification we denote $\frac{m}{m_0} = \mu$ and $\frac{v}{c} = \sigma$ and the relation (1) become

$$\mu = (1 - \sigma^2)^{-\frac{1}{2}} \tag{2}$$

In Fig. 1 the curve (a) represents graphically the relation (2) in the domain of the velocities between $v = 0$ and $v = c$.

In the left side of Fig. 1 is the graph which represent the function $\mu = f(\sigma)$ for $\sigma < 1$ and in the right side is the graph for $\mu = f(\sigma)$ when $\sigma > 1$. This second case will be analyzed in the next chapter.

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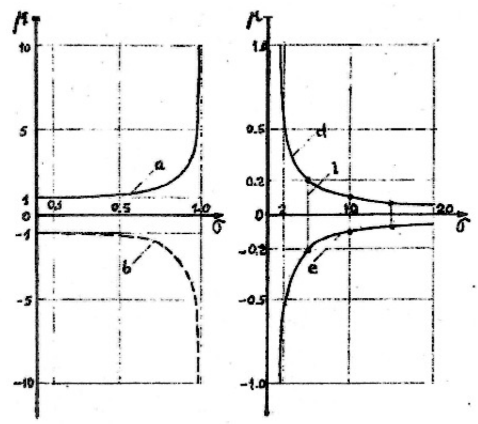

Fig-1

From Fig. 1 (the case $\sigma < 1$) we observe that μ increases relative slowly with the increase of σ above 0 (zero), up to the values of this relation corresponding to some values of the velocity v, which are unusual in the Newtonian Mechanics. Thus, for $\sigma = 0.2$, which means $v = 60,000 km/s$, the increase of μ is only 2%. A more important increase of μ appears for values of σ greater than $\sigma = 0.5$. For example, when $\sigma = 0.6$ the value of $\mu = 1.25$. On the other hand, we can see that for $\sigma = 1$, thus $v = c$, μ becomes $\mu_c = +\infty$. Thus, conform to TR it is not possible to exceed the velocity of light c. We conclude that, mathematically, for $\sigma > 1$, μ would become imaginary. In other words, trying to analyze the variation of the function $\mu = f(\sigma)$ for larger values of σ than $\sigma = 1$ it would enter in DEADLOCK. In what follows we will analyze the possibility to overcome this deadlock.

Since we intend to apply our mathematical model which we will develop in the next chapter in Cosmology, we give bellow some important information accepted by today's Science regarding the "birth" and evolution of the Universe.

It is almost unanimously admitted the idea that the actual Universe is the result of a cosmic evolution which had place after an energetic "explosion" of a magnitude difficult to imagine, produced under a form of a "fire ball" of an infinitesimal dimension (practically in a point), in which was concentrated the entire matter and energy existed presently in this Universe. This explosion was named Bing-Bang (BB) and it happened about 10–15 billions of years ago (considering some earlier calculations for about 13.7 billions of years ago) [2, 3]. In the releasing moment of the BB explosion, the temperature as a parameter of an immense energy is considered to have an infinite value. From this moment the expansion of the Universe started. This process was very rapid, at least in the first period of the time. Still during the moment when BB was produced there were under dispersed form such elementary particles as electrons, protons, neutrons that afterwards constitute the organized matter as much as the corresponding antiparticles of them which are the components of the antimatter.

The Matter (MA) and Antimatter (AM) are the two components of the Substance and at the beginning they were equal, they did not annihilate reciprocally each other as we know it now that it has to happen [4]. It is not known the cause of this "cohabitation". From this reciprocal annihilation of MA and AM results photons and gamma radiations of very high energy.

In agreement with the expansion process the temperature decreased, such as in 1 (one) second after BB, this temperature reached the value of 10 billion K. It is not entirely known in what way the expansion and "cooling" processes were developed in this interval of time between 1 s and 100 s and moreover in the interval between 10 s and 43 s after BB. In any way, before the moment of 100 s after BB, a process to unify the electrons with antielectrons was produced resulting in the formation of the photons. In this way the Universe became a "sphere of light". Also, it is very likely that in this interval of time (from 1 s to 100 s after BB) the annihilation, almost entirely, of MA and AM took place. In this process a lack of balance happened (the cause is unknown) such that a "small rest" of MA remained. Out of this rest the today's visible Universe was formed and it is composed of clouds and super clouds of galaxies.

It is not excluded the idea that before the photons appeared and therefore before having light, some waves of different kind (of strange appearance) than the electromagnetic waves which propagate with the velocity of c, existed. Presently, there is much interest in these waves with velocities $v > c$ [5].

An important phenomenon which takes place in the Universe is that so called "shifting towards red" of the spectral lines which characterize the light emitted by the galaxies. This is due to the fact that the galaxies are shifting. The shifting velocity is proportional with the distance from a certain observer [6]. Thus, for sure that to a specific distance this shifting velocities can rich velocities greater than the velocity of light c.

2. A mathematical model for the mass variation at the velocities greater then c

We intend to overcome this deadlock mentioned in the introduction of this paper, mainly inspired from the recent scientific discoveries. It was shown that the elements which are not waves in nature possessing mass from the Universe structure can have velocities greater then c. Thus, the scientist Patrick Hall of York University from UK discovered that the gas composed from material elements (or possessing mass) emitted by Quasars situated in the galaxy centers are shifting to their periphery with a velocity $v \approx 20c$ [7]. The problem of Pulsars "gas" emission is treated in specialized papers ex. [8]. For this reason, in Fig. 1 the curves d and e (for $v > c$) were graphed up to $v/c = 20$.

In order to reach our purpose we use an unconventional definition of a second power of a measure, for the situation when this has a negative value. This fact is reflected in the following mathematical relation:

$$y^2 = -\left|\varphi\right| \tag{3}$$

We notice the φ can be a function of a certain variable as it happen in our case (see below). In this case the notion of "root" used in [9] and [10] was replaced with "solution".

To find the solutions of some equations of type $y \pm \varphi = 0$ is the subject of our papers [9] and [10] where we analyze the simplest cases $y^2 \pm 1 = 0$.

In the same time we admit that the value of c (the basic element in TR) constitutes a reference point which yields to all phenomena taking place in the Universe, as much as those with velocities smaller than c ($v < c$), and also for those with v greater than c ($v > c$).

We remember that conform relation (2) for $\sigma > 1$ the term $(1 - \sigma^2)$ becomes an imaginary number. Because of this reason, in order to eliminate confusion in the definition of equation (3) using the method in [9] and [10] we will write these solutions under the form:

$$y_1 = +|\varphi|^{\frac{1}{2}} \wedge y_2 = -|\varphi|^{\frac{1}{2}} \tag{4}$$

Between y_1 and y_2 of (4) the symbol $\wedge$ represent the operator AND from the Mathematical Logic.

Thus we have

$$y^2 = y_1 y_2 = |\varphi|^{\frac{1}{2}}\left(-|\varphi|^{\frac{1}{2}}\right) = -\varphi \tag{5}$$

The relations (5) and (3) are identical.

Coming back to the relation (2) and raising its both terms to the power two we obtain:

$$\mu^2 = (1-\sigma^2)^{-1} \tag{6}$$

Applying relation (6) for $v > c$, thus $\sigma > 1$ and considering the relation (4) we obtain the solutions:

$$\mu_1 = +\left(\left|1-\sigma^2\right|\right)^{-\frac{1}{2}} \wedge \mu_2 = -\left(\left|1-\sigma^2\right|\right)^{-\frac{1}{2}} \tag{7}$$

Thus we have a couple of two indissoluble solutions bounded among themselves with the symbol $\wedge$ (bipolar solutions). This fact is represented, in a suggestive way in Fig. 1, where the curves d and e are "bounded" together by the vertical "bars" (links) l.

We mention again that in Ch. 1 we presented the variation of the function $\mu = f(\sigma)$ in relation (2) and Fig.1 curve a as a result to the application of TR regarding Matter (MA).

For a general analyze, taking in consideration as much $\sigma < 1$ as $\sigma > 1$ we put apart these two cases in what follows. For each of the two cases we will have two situations, one corresponding to MA (+m) and the other corresponding to AM (-m).

CASE I.

When $v < c$ and thus $\sigma < 1$. For this case is valid the relation (6) which has the dual solutions (see [9] and [10]):

$$\mu_1 = +(1-\sigma^2)^{-\frac{1}{2}} \tag{8}$$

$\vee$ (or)

$$\mu_1 = -(1-\sigma^2)^{-\frac{1}{2}} \tag{9}$$

In function of the substance kind (MA or AM) considered we have the following situations:

I(a). For MA when the mass "at rest" is $(+m_0)$, we have

I(a.1). The ratio of the masses $\mu_1 > 0$, thus the mass "in motion" is also, $(+m)$, characteristic for MA.

$\vee$ (or)

I(a.2). The ratio of the masses $\mu_2 < 0$, when the mass "in motion" must have the sign −(minus), thus it is denoted $(-m)$, characteristic to AM.

The situation mentioned in I(a.2) is physically impossible and we keep as real only the situation from I(a.1) for which the function $\mu = f(\sigma)$ is graphically represented in Fig.1, curve a, as we have shown in Ch.1.

The situation mentioned in I(a.2) is impossible since up to this time the presence of AM in a natural status in the Universe was not found. However, we consider hypothetically this fact and consequently, the function $\mu = f(\sigma)$ was represented referring to $\sigma < 1$ and AM by the curve b traced with an interrupting line in Fig. 1.

I(b). For AM when the mass "at rest" is $(-m_0)$, we have

I(b.1). The ratio of the masses $\mu_1 > 0$, thus the mass "in motion" is also, with a negative sign $(-m)$, characteristic for AM.

$\vee$ (or)

I(b.2)The ratio of the masses $\mu_2 < 0$, when the mass "in motion" must have the sign +(plus) and it will be denoted $(+m)$, which is characteristic for MA. Surely and these two situations I(b.1) and I(b.2) are physically impossible for the same reason explained above.

CASE II

When $v > c$ thus $\sigma > 1$, the equation (6) becomes

$$\mu^2 = -\left(\left|1-\sigma^2\right|\right)^{-1} \tag{10}$$

And its bipolar solutions will be

$$\mu_1 = +\left(\left|1-\sigma^2\right|\right)^{-\frac{1}{2}} \tag{11}$$

$\wedge$ (and)

$$\mu_1 = -\left(\left|1-\sigma^2\right|\right)^{-\frac{1}{2}} \tag{12}$$

As in the previous case we have two situations as well.

II(a). For MA, when the mass "at rest" is $(+m_0)$ we have

II(a.1). The ratio of the masses $\mu_1 > 0$, thus, the mass "in motion" also is $(+m)$ characteristic for MA

$\wedge$ (and)

II(a.2). The ratio of the masses $\mu_2 < 0$, thus, the mass "in motion" is $(-m)$, characteristic for AM.

II(b). For AM, when the mass "at rest" is $(-m_0)$, we have

II(b.1). The ratio of the masses $\mu_1 > 0$, thus the mass "in motion" is also $(-m)$, characteristic for AM

$\wedge$ (and)

II(b.2). The ratio of the masses $\mu_2 < 0$, thus the mass "in motion" is $(+m)$, characteristic for MA.

In Fig.1, the curve d represents the function $\mu = f(\sigma)$ for $\sigma > 1$, regarding to MA and the curve e represents the same function, regarding to AM. The fact that the solutions μ_1 and μ_2, which can be found (for the same value of σ on the curves d and e are indissolubly bounded by the operator $\wedge$ (and) is represented in this figure by the vertical "bars" l, as it was shown. The curves d and e have apparently a "bizarre" aspect compared with the curves a and b, but the domain $v > c$, thus $\sigma > 1$, can be considered in its turn, "bizarre" too and untouched in respect with the domain of $v < c$, thus $\sigma < 1$, with which we are accustomed. Also, unusual are the above results which lead to the conclusion that, at the velocities greater than the velocity of light, MA "at rest" is transformed in AM when MA passes to the state "in motion" and conversely (AM transforms in MA). These two forms of the substance "cohabit" they do not annihilate each other (see the symbol $\wedge$). Most probably, that this process happens in different proportions between the quantity of MA and of AM in function of the value of v and other factors, as could be the temperature, the level of some radiations, etc. In order to clarify these problems it is necessary to perform a detailed study of the matter clouds evacuated by the Quasars with methods in the fields of Astronomy and Radio-astronomy [7].

3. Conclusions

The Theory of Relativity has a Mathematical Model regarding the body mass in motion (m), showing that this is increasing compared with the mass at rest (m_0), in the same time with the increase of the velocity, as we can see in the equation (1). Its value becomes infinite when the velocity is equal with the velocity of the light c. The increase of the velocity (v) higher than the value of c, conform equation (1) will bring us to the imaginary values of the mass m, thus to the DEADLOCK.

In order to exit from this deadlock we apply the method of solving a couple of very simple second degree equations of the type $y^2 \pm \varphi = 0$, starting from the simplest ones $y^2 \pm 1 = 0$, which was developed in [9] and [10]. This will bring us to the "dual solutions" of type $y_1 \vee y_2$ or "bipolar solutions" of type $y_1 \wedge y_2$, which implicitly demand the introduction in this analyzes of the notions of the Matter (MA), with the mass $(+m_0)$ at rest and $(+m)$ in motion and respectively the notion of the Antimatter (AM), with the masses $(-m_0)$ and $(-m)$. Treating in this unitary way both of them, the problem as much for the situations $v < c$ and $v > c$, as for cases MA and AM, it results that in the first situation $(v < c)$ we have as valid the dual solutions and for the second situation $(v > c)$ we have as valid the bipolar solutions. In Fig.1 we give the graphical representation of the resulted relations in this way:

curve a, for MA and $v < c$;
curve b, for AM and $v < c$;
curve d, for MA and $v > c$;
curve e, for AM and $v > c$.

We mention that the curve b, traced with an interrupted line, represent an hypothetical case, since up to date in the Universe the presence of AM in a natural form could not be found. AM was found only in the laboratory conditions. The curves d and e, for $v > c$, are bounded together indissoluble, since they are constituted from points which represent the bipolar solutions. Graphically this thing is marked by the bars l.

The bipolar solutions, which constitute the mathematical support of the curves d and e, bring us, at the first glance, to a bizarre conclusion that the increase of the velocity above the value of c causes a change of the substance from MA in AM and vice versa, from AM in MA without their reciprocal annihilation and they are bound to "cohabitate" together. Such a possibility is admissible if we appeal to these phenomena studied by the Cosmology in the process of the Universe formation after the Bing- Bang. These kinds of phenomena and their evolution are presented briefly in Cpt.1 of this paper.

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