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A small correction to the limiting speed transmission of information due to the Hubble constant.

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Abstract.

It is known that the global constant called the speed of light, which has the meaning of the limiting data transmission speed, is used in the theory of relativity. This rate is determined using the speed of light since no higher speed has been discovered.

The constant called Hubble's constant is also used in research. It means the rate of Universe expansion due to variation in the metrics. This rate is calculated per 1 mega parsec, but it can be calculated for any small distance.

According to the axiomatic quantum field theory, there is a distance where axiomatic statements become ineffective when they are shorter. This variable is called distance quantum. Let us calculate Hubble's constant according to this distance. In fact, the expansion rate is increased by this variable in transition from a distance quantum to the next one.

The expansion rate and speed of light yield true data transmission speed. We have calculated the difference in the expansion rates in the different local areas. This difference leads to the difference in the forces of interaction in the different local areas, which makes it possible to discover the force that always results in attraction in all electrical interactions. The proposed calculation gives the value the order of which is close to the force of gravitational interaction.

Other properties of this new force appear in explanations for the acceleration of Universe expansion and inertia.

Keywords.

Speed of light, limiting speed, data transmission speed, electrical interaction, inertia, gravitational interaction.

1) **Correction to Limiting Speed.**

This negligible correction will not have a strong effect on anything, if any. However, it is worth to take it into account since below an example is given, which demonstrates a negligible change in the result. This limiting speed is contained in the theory of relativity formulas and is denoted as c.

We make a very rough estimate of the orders; therefore, we will not consider quantum-mechanical behavior and will write "particle" having in mind that this particle possesses properties of a macroscopic object. Besides, we will write "force" implying the time derivative of the momentum.

Thus, if a particle sends a signal with the speed of light in its local area, the distance the signal passes will be a bit longer than the distance this signal would pass if we took into account its speed only. There occurs a slight change due to the variation in the metrics, which is described by Hubble expansion. This expansion can easily be recalculated for any small size. Besides, it is clear that this expansion will be not exact zero. The smallest size has not been precisely determined; however, when considering the axiomatic field theory, it has been found that some original axiomatic statements remain effective to distances of about $5 * 10^{-16}$ cm. [2]

Let us remember now that the space we consider does quantize since the existence of ultraviolet divergences in the quantum field theory can be avoided by introducing the shortest distance [3]. This means that there is a small nonzero local area so that in the smaller areas the space is not considered. We denote the diameter of this area as q. In our case, Hubble's constant is equal to the speed H per 1 mega parsec; let us calculate the speed H for the distance q and denote it as h. Here, this speed is the addition to the speed of light used to determine the signal transmission speed over the distance q. It is clear that the data transmission speed and the expansion rate h are located in the same frame of reference – the particle frame of reference. This empowers us to obtain the sum of these rates simply by addition: $w = c + h$.

Besides, it is borne in upon us that h is the small constant calculated for the distance q similarly to Hubble's constant calculated for the distance of 1 Mps. Therefore, counting distances from the particle, we can obtain the expansion rate of any small area. If we choose a point M and consider the straight line that passes through the particle and the point M, the area on this straight line in front of the point M is expanded with the rate h_1, while the area behind the point M is expanded with the rate h_2.

Since we obtained different expansion rates in different local areas, that leads us to the fact that data transmission speeds in different local areas are also different. This yields a negligible value variation of w in different local areas and negligible changes in the results, which follow from the formulas of the theory of relativity.

2) **An Example to Show That the Small Correction Cannot Be Absolutely Neglected.**

Let us consider the following simplified imaginary experiment: a charged particle A attracts the other charged particle T, which moves along the straight line connecting the points A and T. The following formula that describes this interaction is known [1]:

$$\frac{dp}{dt} = \frac{m}{(1-\frac{v^2}{c^2})^{\frac{3}{2}}}\frac{dv}{dt}. \qquad (1)$$

If an additional particle B is located near the particle A and the charge of the particle B is the same, but opposite in sign to the charge of the particle A, the particle B repulses the particle T and this repulsion is described by the above-presented formula.

It is clear that, if the limiting speed is taken without account for the small correction, the complete compensation for the effect of the charged particles on the particle T occurs in accordance with formula (1).

If this correction is taken into account, in the case of repulsion the local area of interaction is positioned further from the particles A and B than the local area of attraction. We keep in mind that in this case the limiting speeds are different; therefore, no complete compensation for the effect of the particles A and B on the particle T occurs. The residual interaction is negligibly weak compared to the electrical interactions between the particles.

3) **Rough Estimate of Residual Interaction Order in Imaginary Experiment under Consideration.**

Let us introduce slight changes into the designations to make them more usual. Here, u is the additional speed due to Hubble expansion, v is the speed of the particle T and c is the speed of light.

To simplify the calculation, we assume that in the local area where attraction is considered, Hubble expansion has zero effect. In the area where repulsion is considered, the effect of Hubble expansion yields the additional speed u. We only need to consider these two areas and the difference in the effect of Hubble expansion on the data transmission speed in these areas. The speeds v of the particles are root-mean-square speeds of such particles.

The repulsion force f_1 and the attraction force f_2 are determined as follows:

$$f_1 = \frac{m}{(1-\frac{v^2}{(c+u)^2})^{\frac{3}{2}}}\frac{dv}{dt}; \qquad (2)$$

$$f_2 = \frac{m}{(1-\frac{v^2}{c^2})^{\frac{3}{2}}}\frac{dv}{dt}. \qquad (3)$$

Let us consider the case $v << c, u << c$. Therefore, we obtain the following relation:

$$\left(1-\frac{v^2}{(c+u)^2}\right) = 1-(\frac{v}{c})^2\frac{1}{(1+\frac{u}{c})^2} = 1-\left(\frac{v}{c}\right)^2\left(1-2\frac{u}{c}\right).$$

Now, we again make an approximate calculation, assume repulsion to be the positive direction, which yields the following formula:

$$\Delta f = -f_2 + f_1 = m\frac{dv}{dt}\left(-\left(1+\frac{3}{2}\frac{v^2}{c^2}\right)+\left(1+\frac{3}{2}\left(\frac{v}{c}\right)^2\left(1-2\frac{u}{c}\right)\right)\right)$$

or

$$\Delta f = -3m\left(\frac{v}{c}\right)^2\frac{u}{c}\frac{dv}{dt}. \qquad (4)$$

There are various evaluations of the shortest distance, but our concern is with the approximate force order. Therefore, we turn our attention to the distance taken from the axiomatic field theory of $5*10^{-18}$ m.

Let us consider Hubble's constant, which is calculated per 1 Mps, to be equal to 70 km/s and 1 Mps to be equal to $35*10^{21}m$. Therefore, Hubble expansion at the shortest distance yields the following speed:

$$u = \frac{70{,}000*5}{35*10^{21}*10^{18}} = 10^{-35} \text{ m/s.}$$

The qualitative evaluation of the electron speed in a hydrogen atom is as follows:

$$v = \frac{c}{137} = 2.2*10^6 \text{m/s.}$$

The required relation is the ratio of the obtained force of the interaction between the particles due to the introduction of the correction to the calculated force of the electrical interaction between these particles. It is written as follows:

$$K = \frac{\Delta f}{(m\frac{dV}{dt})} = -3\left(\frac{v}{c}\right)^2\frac{u}{c};$$

$$K = 3*(2.2*10^6)^2\left(\frac{1}{3*10^8}\right)^3 10^{-35}=5.3*10^{-48}.$$

Thus, using the very rough estimate and taking the very approximate values, we obtain the resultant force, which is only by three orders of magnitude less than the force of the gravitational interaction calculated for these particles. For the particles themselves, this is zero interaction, but for large objects, such as stars, it can play a significant role.

Since our calculation is very approximate and only the movement along the straight line that connects the particles is considered, chances are this is precisely the gravitational interaction force that follows from the variation in the metrics, which, in turn, is calculated using the general theory of relativity.

4) **Acceleration of Universe Expansion.**

We obtain this characteristic using formula (1).

Our concern is with large distances where $v \sim c$ and $u << c$. At these distances, all speeds of the particles are directed towards removal, which is related to Universe expansion. Therefore, the correction (in different local areas) to the speed is the same as the correction to the data transmission speed, which is described by the following relation:

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

In this case denoted by the superscript d, the forces are calculated as follows:

$$f_1^d=\left(1-\frac{3}{2}\left(\frac{v}{c}\right)^2\left(1+2\frac{u(c-v)}{cv}\right)\right)m\frac{dv}{dt}$$

$$f_2^d=\left(1-\frac{3}{2}\left(\frac{v}{c}\right)^2\right)m\frac{dv}{dt}\,.$$

Therefore, we obtain the following formula:

$$\Delta f^d=-3\left(\frac{v}{c}\right)^2\frac{u(c-v)}{cv}\;m\frac{dv}{dt}.$$

It is easily seen that at Universe expansion rate $v>c$ the attraction force changes its sign and becomes the repulsion force.

Note that we used the very approximate evaluation and assumed the rate v to be Universe dispersal speed for the defined area. But this speed can additionally contain the values of the fundamental speeds of the particle. In fact, the rate v can be substantially lower for a separating force to arise.

This means that in the proximal areas attraction will occur and Universe expansion will follow Hubble's law, but distant areas repulsion will exist, i.e. these areas will accelerate expansion.

5) **Inertia.**

The mechanism of inertia can be explained fairly simply using the above-considered correction. It is natural to assume the distribution of all particles in the Universe to be homogeneous and uniform. At distances where $v<c$, all objects are attracted to each other in accordance with formula (4):

$$\Delta f=-3m\left(\frac{v}{c}\right)^2\frac{u}{c}\frac{dv}{dt}\,. \qquad (4)$$

It can be seen that this formula contains the acceleration; if it occurs in some direction, an opposite force arises. It is clear that the gravitational and inertial interactions are proportional to each other provided that they are calculated using the above-presented formula and the corresponding masses are also proportional to each other.

6. **Conclusion.**

Taking into account the correction to the limiting speed yields the simplest explanation for gravitational interaction, inertia, and the accelerated Universe expansion. The use of this correction will open great possibilities of explaining new facts.

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