

## **Quantum field theory explains the accelerated expansion of the universe.**

### **Abstract.**

Expansion of the universe by Hubble, allows you to calculate the expansion at a minimum distance. This leads to the fact that the limiting speed of information transfer varies depending on the distance and depending on the local site in question. This gives a different interaction when the particles are repelled from each other and when they are attracted. This leads to the appearance of a nonzero residual interaction. And this leads to an explanation of the accelerated expansion.

### **Keywords.**

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

#### **01. Limiting speed.**

It is known that the association of the Special Theory of Relativity and Quantum Mechanics gives good results in theoretical physics. An interesting result can be got, if to examine eventual small areas. But General Theory of relativity examines areas the size of that aspires to the zero. From the axiomatic theory of the field we know that the size of area, where the axioms of our physical space are executed, makes  $5 * 10^{-18}$  m [1]. We will consider that within the limits of this area maximum speed of information transfer does not change. As is generally known, she is designated by the letter of "c" in the special theory of relativity.

Since it is known from the General Relativity Theory that there is a change in the metric with time and, accordingly, with the distance, in fact all our small areas cannot be considered as Inertial Systems of Counting, even if they had reference bodies. That is, it turns out that these are independent noninertial regions in which the existence of different limiting velocities is not forbidden. It is also clear that, depending on the distance from the observer, the change in the metric is different, according to the Hubble law, recalculated for a short distance instead of a megaparsec. Therefore, in the local areas located at different distances from the observer, the light (or similar to the light) signal will travel a different distance at the same time. The increase in distance due to the Hubble expansion is not inertial

and occurs in the same frame of reference as the motion of the light signal. Therefore, we add velocities according to Galileo's formula, according to the Special Theory of Relativity.

In fact, we have obtained that in different local areas independent of each other, information transfer occurs at different rates, that is, the value of the constant "c" for each local area is different. It is clear that the area located farther from the observer has a larger metric change, so the information transfer rate is greater there.

## 02. Interactions in the areas.

We now recall that the de Broglie wave (for an electron and a photon) is approximately  $l_e = 2,4 * 10^{-12}$  m, which is 6 orders of magnitude larger than the size of the region under consideration, so we can not speak of a field in this area. For example, an electron is smaller than the considered area by more than 4 orders of magnitude. Consequently, in this area one can speak of a free charged particle, on which an extraneous "force" acts. By force is meant the time derivative of the momentum. This force is the usual Coulomb interaction. In general, the formula is complex. Therefore, let us consider a simplified special case of this formula for a force acting along the line of motion of a particle. The formula is simple and is described in the literature [2]:

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

Now consider a simplified thought experiment.

One charged particle A attracts by formula (1) another free charged particle T that moves along the straight line connecting A and T. If next to A is placed another particle B, with the same charge as A, but with another sign, then B will repel the particle T.

It is clear that the shift in some direction of the particle must be at least a smaller of the distances, or by the value of the local area. Therefore, the motion of the particle towards the observer will be in one local area. Removal will be in the more distant local area, relative to the observer. That is, they obtained that when the particle is removed, the information transfer rate should be considered more than when the particle is approached. We also remember the superposition of all interactions, and hence the possibility of considering each interaction separately.

## 03. The residual interaction formula.

We obtain formulas for certain residual interactions because of the difference in the limiting rates of information transfer in different local areas.

The additional speed is  $-u$ , because of the Hubble expansion,  $v$  - is the velocity of the particle  $T$ ,  $c$  - is the velocity of the light signal.

For simplicity of calculations, we shall assume in the local area where the attraction is considered, the influence of the Hubble expansion  $= 0$ . And in the region where repulsion is considered, the influence of the Hubble expansion gives an additional velocity  $u$ . We only need these two areas and the difference in them is the influence of the Hubble expansion on the speed of information transfer. Velocities of  $v$  particles are certain rms velocities of such particles.

Repulsive force  $f_1$ , other attraction force  $f_2$ .

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

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

### 03.01 Attraction.

Consider  $v \ll c, u \ll c$ . Then:

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

Our calculation is approximate. Acceleration we take in absolute value. A possible sign will be taken into account in the case of force. Positive direction is chosen - repulsion:

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

Or

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

That is, we have not a zero residual interaction.

### 03.02 Repulsion.

Now consider significant distances, where  $v \sim c, u \ll c$ .

At such distances, all particle velocities are directed at removal, which is connected with the expansion of the universe. Therefore, the correction (in different local areas) to the particle velocity will be the same as for the information transfer rate.

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

Or in this case (symbol d), the forces will be:

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

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

Then

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

It is easy to see that at the rate of expansion of the Universe  $v > c$ , the force of attraction changes sign and becomes a repulsive force.

It should be noted that we have a very rough estimate and speed  $v$  is taken as the speed of the Universe dispersal for a given region. Although this speed can also include the values of the particle's own velocities. That is, in fact, the velocity  $v$  can be much lower for the occurrence of a pushing force.

If we take into account all possible particles, their finest fragmentation and superposition, then there will be a significant influence in the Scales of the Universe. That is, the near areas will attract, the universe will expand according to the Hubble law, but the distant regions will be a little repulsive, that is, give acceleration to expansion.

#### References:

1) "Quantum Field Theory", Physical Encyclopedia,  
[https://dic.academic.ru/dic.nsf/enc\\_physics/1340/%D0%9A%D0%92%D0%90%D0%9D%D0%A2%D0%9E%D0%92%D0%90%D0%AF](https://dic.academic.ru/dic.nsf/enc_physics/1340/%D0%9A%D0%92%D0%90%D0%9D%D0%A2%D0%9E%D0%92%D0%90%D0%AF)

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