LETTERS TO PROGRESS IN PHYSICS

On the Possible Nature of Dark Matter and Dark Energy

Analtoly V. Belyakov
E-mail: belyakov.lih@gmail.com

It is assumed that the dark matter particle can be a structural unit of cosmological scale (superphoton) emitted by the active center of galaxies, analogous to a photon and ball lightning (macrophoton), which are structural units of micro- and macroscales. The low density, potential and temperature of superphotons make them invisible during astronomical observations, and their negative charge prevents the galaxies from approaching each other which can explain the phenomenon of dark energy. It is shown that the existence of superphotons together with the presence of cosmic rays indicates the conservation of the electric charge as a whole in cosmological scales. It is assumed that the superphoton, like a giant ball lightning with energy of 1.03×10^{17} J, could collide with the Earth which could explain the Tunguska phenomenon.

1 Introduction. On the natural range of the unit structural objects

In nature, as the scale changes, a regular range of certain single structural objects is observed. Let us consider them from the point of view of the mechanistic interpretation of J. Wheeler's geometrodynamic [1].

So, in the microcosm opposite charges (the proton and the electron, for example) are connected by a current vortex tube, forming as a whole a closed contour based on the *balance of magnetic and gravitational forces*; its structural unit is a *photon* (wave). The number of these units depends on the contour size, i.e. on the main quantum number n. The size of the "standard" contour $r_{st} = 1.25 \times 10^{-9}$ m. It contains approximately 137 photons (the inverse of the fine structure constant) [1,2]. In the limit, the contour can have one photon, that is, being identical to the photon itself.

A photon, like the contour itself, is a one-dimensional object; the photon does not exist at rest alone.

In the area of Earth's scales between charged macroobjects — a thundercloud and Earth — a linear lightning arises, also a kind of the current tube that generates a ball lightning, which, in turn, can be regarded as a structural unit. Calculation of the parameters of a typical ball lightning, provided that it has a mass close to the Planck mass (quasiparticle) is described in [3]. It is assumed that the ball lightning consists of many single elements — photons or of one long closed contour packed into a spherical shape, forming a *macrophoton*. A macrophoton is a multilayer spherical capacitor, i.e. a kind of two-dimensional object; the lifetime of a macrophoton is limited.

As for cosmic scales, there was shown in [4] that the structure of quasars can contain very long open vortex tubes with opposite currents carrying charges of different signs at the place of their rupture that resembles a kind of a superatom. Vortex tubes consist of vortex threads, which, supposedly, can be transformed into compact structural units — *superphotons* emitted by a quasar. Accordingly, continuing the analogy, the superphoton should be a three-dimensional object, and its lifetime is unlimited.

Indeed, galaxies form a homologous generation — from galaxies with a quasar in the center to galaxies with a black hole in the center. Thus, if a black hole absorbs matter, then the quasar as a white hole (the superdense body according to Ambartsumyan) generates matter. Then galaxies with quasars passing into a state of galaxies with black holes should radiate (to split off) part of its mass in the form of some particles.

2 On the possible super-photon structure

In [4] some parameters of the "standard" quasar were calculated, namely such ones, where the speed of the medium along the vortex tubes is that of "standard" proton-electronic contour. In particular, the following are defined:

quasar mass M, kg	4.76×10^{42}
quasar total energy E, J	9.61×10^{53}
length of the quasar vortex tube l, m	1.58×10^{21}
mass of 1 vortex threads of a quasar tube m_i, kg	5.10×10^{5}
number of unit threads const. the vortex tube, z	9.33×10^{36}

If the vortex thread forms a certain stable structure, then, obviously, certain balances of interactions must exist to maintain such a structure in equilibrium.

So, in [4] it is calculated that there is a *balance of the vortex tube kinetic energy and the electrostatic energy* of all single charges (not necessary electrons) placed along the vortex tube length, provided the distance between the vortex threads is equal to the size of the "standard" proton-electronic contour r_st and the maximum single charges number must be

$$z_{ie} = l/r_e = 5.6 \times 10^{35}, \qquad (1)$$

where r_e is the electron classical radius (2.82×10^{-15} m).

At the same time, when the vortex threads are split off from the vortex tube, for a pair of threads a *balance of electric* *and magnetic forces* must be realized that leads to a geometric mean [5]:

$$(l_i\, r_{st})^{1/2} = 7.52 \times 10^8 \text{ m}, \tag{2}$$

from which follows $l_i = 4.52 \times 10^{26}$ m.

Let us assume that this extended one-dimensional structure, i.e. a double vortex thread with charges of opposite signs can somehow be packed into a compact volume (similar to a double helix of DNA). In the most dense packing its linear dimension D can be estimated as

$$D = \left(l_i\, r_{st}^2\right)^{1/3} = 890\,\text{m}. \tag{3}$$

Further one can find other averaged parameters of the object — density, energy, charge and potential:

$$\rho = m_i/D^3 = 0.72 \times 10^{-3} \text{ kg/m}^3, \tag{4}$$

$$E_i = E/z = 1.03 \times 10^{17} \text{ J}, \tag{5}$$

$$Q_i = z_{ie}\, e_0 = 9.0 \times 10^{16} \text{ K}, \tag{6}$$

where e_0 is the electron charge,

$$U_i = E_i/Q_i = 1.14 \text{ V}. \tag{7}$$

It is important that in this volume the average distance between charges d is close to the size of the "standard contour" r_{st}, i.e. the *balance characteristic of the proton-electronic contour is also realized*. Really,

$$d = \left(D^3/z_{ie}\right)^{1/3} = 1.08 \times 10^{-9} \text{ m}. \tag{8}$$

Recall that all of the above calculated values are the result of using only the fundamental values.

Thus, when carrying out these balances, one can expect that such an object is stable and exists for a long time. Let's estimate this time, assuming that its object radiates as an absolutely black body and has a surface temperature close to the cosmic background radiation temperature $T = 2.7^\circ$ K (otherwise such objects would be seen in the process of astronomical observations). The power radiated by its surface is determined from the well-known formula:

$$N_i = T^4 \sigma S, \tag{9}$$

where σ is the Stefan-Boltzmann constant, equal to 5.67×10^{-8} Wm^{-2} (^{0}K)$^{-4}$, and S is the sphere area of diameter D equal to πD^2. Substituting the data, we get $N_i = 7.5$ W and than the lifetime of the object is:

$$\tau = E_i/N_i = 1.37 \times 10^{16} \text{ sec or 442 million years}, \tag{10}$$

which in order of magnitude corresponds to the lifetime of a quasar. Obviously, such an object can exist for a longer time, since it gradually dissipates its power and reduces the radiation temperature.

3 Superphoton as a candidate for the role of dark matter

A superphoton, unlike a ball lightning, has an insignificant density, potential, and surface temperature, hence it interacts with other bodies only *in a collision or through gravity*. Therefore, this object, inconspicuous against the background of relic radiation, can claim the role of the desired dark matter. The generality of its origin with ordinary baryonic matter is obvious; this possibility is also allowed in [6]. Let us assume that as the quasar "burns out" (before becoming into a galaxy), most of its mass is radiated in the form of superphotons (dark matter), and less of its mass remains in the form of a conventional galaxy (baryonic matter). Then the ratio of these masses should be close to the mass ratio of the quasar to the galaxy minus one. The calculated mass of the "standard" quasar is about five times greater than the baryon mass of our Milky Way galaxy [4]; for most other galaxies, less massive, this ratio is even greater. Thus, the ratio of the mass of superphotons to the mass of the average galaxy is generally consistent with the ratio of the dark matter mass to the baryonic matter mass. According to WMAP (Wilkinson Microwave Anisotropy Probe, 2003), the universe contains: dark matter of 22%, baryonic matter of 4%.

Apparently, young galaxies as the most massive and active should gradually lose their mass and reduce activity. This provision is consistent with the recently discovered of very massive young galaxies, about one billion years of age that produce stars with intensity much higher than the rate of star formation in our galaxy the Milky Way [7].

If the superphoton has kinetic energy relative to the point of origin (the quasar center) equal to its internal energy, then its relative velocity is equal to the circulation velocity of the medium along the vortex tube (for the "standard" quasar, $\upsilon = 448,000$ m/sec), i.e. it is close to the escape velocity. If particles are emitted mainly in the disk plane, then in this case their total velocity (peripheral velocity plus particle one) exceeds the escape velocity. Thus, during its lifetime (quasar activity), super-photons can move away from galaxies and fill the halo of galaxies, thereby playing the role of dark matter. In this case, in the most remote galaxies, i.e. the youngest from the point of view of observers, dark matter should be less. Indeed, this fact is established [8, 9].

According to the model, the super-photon is a cold and slowly moving formation that corresponds to the model of Cold dark matter. And just in favor of this particular model, the results obtained by a group of astronomers led by Vid Iršič, who analyzed the distribution of dark matter in the universe, based on observations of the lyman alpha radiation from distant galaxies obtained with the help of the Keck Telescope (Hawaii) and the Very Large Telescope Observatory (Chile) indicate [10].

Some features of the behavior of dark matter is not yet amenable to computer simulation: the cosmological models of formation and evolution of disk Galaxies, the distribution of the density of dark matter in the galaxy disk (the problem of the central cusp), coplanarity dwarf galaxies-satellites relative to central galaxies, weak interaction of clouds of dark matter among themselves and others [11]. Therefore, it would be interesting to perform computer simulation, believing that dark matter particles have the properties of superphotons and move mainly in the plane of the galaxy disk.

The average density of particles in the form of superphotons in a galaxies interior, including the halo of diameter 10^5 light years, is very small, about one particle per cubic with a side of 0.5 million kilometers, which gives 5×10^{-24} g /cm^3. And, having the same charge, superphotons repel each other and can not form clusters. Therefore clouds of dark matter can freely intersect without significant interaction. At this density of dark matter and even several orders of magnitude greater (in the case of dark matter distribution mainly in the disc plane), its presence in the solar system can not be detected, which corresponds with the conclusions [12].

Let's try roughly to estimate the probability of a superphoton collision with the Earth. Let's assume that during our existence (1.3×10^{10} years) our galaxy has lost 4/5 of its baryonic matter due to the uniform radial radiation of superphotons on its inner spherical surface with a diameter of 10^5 light years. Then the number of super-photons from the total number of them ($\frac{1}{2} \times \frac{4}{5} \times 9.33 \times 10^{36} = 3.73 \times 10^{36}$) that fall per unit sphere area is 10^{-16} units per m^2 per year. Accordingly, 0.013 units per year (one superphoton at 77 years) fall on the globe cross-section or, in terms of unit charges, there are 1.46×10^{34} charges per year.

This is a reasonable value, but in reality this probability is much less and not only because of shading of the Earth by other cosmic bodies, dust, etc. The main reason is obviously the age of our galaxy and the presence of a black hole at its center; so we can assume that by now the radiation of superphotons is replaced by the reverse process — the absorption of matter by a black hole. Superhotons are carriers of namely negative charges, since there simultaneously are streams of positively charged particles — *cosmic rays*; at the same time negative and positive charges should be compensated in space as a whole. Obviously, there is some physical mechanism that separates the primary plasma into particles of opposite signs. Positive particles (mainly protons) form cosmic rays, and electrons are decelerated in interstellar magnetic fields (the material basis of the vortex tubes in our model).

The intensity of cosmic rays at the surface of the Earth is approximately one particle per cm^2 per second or 1.6×10^{26} particles per year on the entire Earth surface that is eight orders of magnitude less than the number of negative charges. However, the characteristic scale of the propagation of slow superphotons is the size of the galaxy (10^5 light years), and the similar propagation scale of cosmic rays, provided that they are uniformly distributed throughout the cosmic space, is the size of a larger structure — the cell of the cosmological network or the vault (10^7–10^8 light years). Thus, the unit density of particles in the corresponding volumes, i.e. cube ratio of linear scales, corresponds to the same order of magnitude.

4 On the forces of repulsion and dark energy

If the hypothesis of a superphoton is correct, then the galaxies periphery, where dark matter is mainly accumulated, should be surrounded by a distributed negative charge, which should counteract the "clumping" of galaxies between each other and also the walls of galactic vaults as a whole. Considering the masses and charges of galaxies at very great distances as point ones, it is possible to determine the magnitude of the equilibrium negative charge, at which electric forces are compared with gravitational ones:

$$Q = 2M\,(\pi\,\varepsilon_0\,\gamma)^{1/2}\,, \tag{11}$$

where ε_0 and γ are known electric and gravitational constants. Substituting the data, we find for the "standard" mass of the quasar $Q = 4.08 \times 10^{32}$ Coulomb.

Neither the charge distribution around galaxies nor its fraction responsible for the repulsive force between them is known. Therefore, for a rough estimate of the smallest value of the acting charge it suffices to restrict oneself to only the fraction of superphotons enclosed in a single spherical layer along the halo periphery, and — in the superphotons themselves — to a single spherical layer of negative charges along the periphery of superphotons. It was previously calculated that in the halo volume of 10^5 light years in size, the superphoton occupies the cell of 5×10^8 m; then, based on the areas ratio, one can find that 1.13×10^{25} superphotons can be placed in a single peripheral layer of the halo. Similarly, bearing in mind the dimensions of the superphoton D and the standard contour r_{st}, one can find that 1.59×10^{24} charges can be placed in the peripheral layer of the superphoton. Thus, the effective minimum charge of the "standard" galaxy will be $1.13 \times 10^{25} \times 1.59 \times 10^{24} \times e_0 = 2.87 \times 10^{30}$ Coulomb or 0.7% of the equilibrium charge. This is already an appreciable value; therefore, with more number of active charges, for example, with the expansion of the halo surface, the repulsive forces between galaxies can increase up to exceeding them above the forces of gravitational attraction.

So, if this hypothesis is correct, then in the space between galaxies and their clusters the electric field also acts, and the electrostatic repulsive forces beyond the galaxies have the same distance dependence as the gravitational ones, i.e. inverse quadratic form. This is consistent with the opinion of some researchers that "the physical nature of dark energy is determined by the interaction of gravitation and electroweak forces" [13]. These forces manifest themselves as antigravity, which in total can be interpreted as a *modification of the theory of gravity at extremely long distances and cosmological durations* [6], which is one of the explanations of dark energy accepted to date.

Conclusion

Thus, the super-photon, bearing in mind its properties, may turn out to be the desired dark matter or the missing substance of the universe. Its existence as a carrier of negative charges is indirectly confirmed in the existence of cosmic rays — carriers of positive charges that correspond to the condition of the charge conservation in the universe as a whole. In the case of correctness of the model presented, the problem of dark matter and dark energy finds the most rational explanation: dark matter (superphotons having a negative charge) is a product of the evolution of ordinary matter, and dark energy (repulsive forces) is the property of dark matter.

Of course, the superphoton is such a "particle" that clearly does not meet the expectations of researchers studying dark matter. Perhaps direct evidence of the existence of superphotons can be detected by observations during their interaction with the Sun or against the background of the Sun's disk, the probability of which is four orders of magnitude higher than when super-photons interact with the Earth.

There is only one event that could be explained by the collision of the superphoton with the earth — this is the Tunguska phenomenon. Indeed, the superphoton as the analog of a giant ball lightning with an energy of 1.03×10^{17} J, in size of 890 m and moving at cosmic speed could produce the specific effects of the Tunguska catastrophe, including those that are not explained by the currently dominant meteorite hypothesis [14].

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