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Dark-Matter Structures: Mass, Sizes and Detection

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Abstract: Dark-matter (DM) structures are built of the entangled (it is the superluminal quantum entanglement) Einstein-spacetime components moving with the invariant speed of light in "vacuum" c (they are the non-rotating-spin-1 neutrino-antineutrino pairs). The big DM structures, i.e. the DM halos and DM filaments, are built of the DM circles with invariant mass about 47 powers of ten lower than 1 kg and very different sizes and angular momentums. Of course, two DM circles with antiparallel angular momentums can create a spin-0 structure that looks similar to the Scale-Symmetric-Theory (SST) pion or very early Universe - mass of such DM pion is two times higher than a single DM circle. But observed behaviour of DM structures suggests that most numerous are the DM circles. Lower limit for their radius is about 13 powers of ten smaller than 1 m whereas upper limit can be arbitrary and is defined by distribution of baryonic matter (BM) with which the DM circles interact via leptons. The DM circles were produced at the beginning of expansion of the Universe. There, for example, are in existence the cosmological DM rulers/loops with a radius of 151 Mpc. Quantum entanglement is much stronger than the DM-BM interactions so even during collisions of galaxies, the DM circles cannot be destroyed (they can be separated from baryonic matter and they can change size). Since the Einstein-spacetime components in the DM circles/pions do not rotate and their speed is invariant whereas mass of the DM circles is very small, even indirect detection of DM structures is not an easy task.

1. Introduction

The Scale-Symmetric Theory (SST) shows that the successive topological phase transitions of the superluminal non-gravitating Higgs field during its inflation (the initial big bang) lead to the different scales of sizes/energies [1A]. Due to a few new symmetries, there consequently appear the superluminal binary systems of closed strings (the spin-1 entanglons) responsible for the quantum entanglement (it is the quantum-entanglement scale), neutrinos and the spin-1 neutrino-antineutrino pairs moving with the speed of light in "vacuum", c, which are the components of the gravitating Einstein spacetime (it is the Planck scale), cores of baryons (it is the electric-charge scale), and the cosmic-structures/protoworlds (it is the cosmological scale) that evolution leads to the dark-matter (DM) structures (they are built of entangled non-rotating-spin neutrino-antineutrino pairs), dark energy (it consists of the additional non-rotating-spin neutrino-antineutrino pairs interacting gravitationally only i.e. they are not entangled) and the expanding Universe (the "soft" big bang due to the inflows of the dark energy (DE) into the Protoworld which created the early Universe) [1A], [1B]. The electric-charge scale leads to the atom-like structure of baryons [1A].

We know that classical mass of electron differs from the quantum one. Within the SST, we showed that it results from two different ranges that concern the internal structure of bare electron [2]. How the quantum-classical mass problem for electrons is solved for neutrinos? Gravitational mass of neutrinos, which is produced due to the interactions of the entanglons the neutrino consists of with the Higgs field, is very low $m_{neutrino} = 3.3349306 \cdot 10^{-67}$ kg – it is the particle mass [3], [1A]. But there is as well the wave mass (associated with size of a rotating bare neutrino), which is close to the Planck mass [3]. It means that for rotating neutrino we must take into account both masses i.e. the particle mass and wave mass [3]. Calculated within SST sum of mean masses of the three species of neutrinos is 0.287 eV [3] – it is consistent with experimental data. Since the DM structures are built of the entangled non-rotating-spin neutrino-antineutrino pairs so mass of the DM-structures components is the particle mass i.e. is about $m_{pair} \approx 6.67 \cdot 10^{-67}$ kg. Knowing this mass, knowing density of the Einstein spacetime (mean distance between the neutrino-antineutrino pairs in this spacetime is about $L \approx 3.93 \cdot 10^{-32}$ m [1A]), and structure of the very early Universe, we can calculate mass and sizes of the most numerous DM circles and the not numerous DM pions that are the binary systems of DM circles with antiparallel angular momentums.

The big dark-matter (DM) structures, i.e. the DM halos and DM filaments, composed of the DM circles, were produced in the very early Universe.

The DM structures are not a part of the Einstein spacetime or DE, which try to be flat. SST shows that total mass of DM circles should be 5.39 times higher than the mass of baryonic matter [1B].

Notice that the DM circles or DM pions with different sizes can decay to smaller DM segments or to the single non-rotating-spin neutrino-antineutrino pairs interacting gravitationally only i.e. to the DE particles (the quantum entanglement must be destroyed). But in my opinion, due to the very big coupling constant for quantum entanglement [1A], probability of such processes is very low – we can see that even collisions of galaxies cannot destroy the DM circles. They can be separated from baryonic matter or stretched without a change in mass by expanding baryonic matter with which they interact via leptons.

Here, applying the SST, we calculated mass and sizes of the DM circles and DM pions and we described the limitations for their detection.

2. Mass and sizes of the DM circles and DM pions

SST shows that due to the quantum entanglement, if smaller structure is built of x objects then the next bigger one consists of x^2 such objects, and so on [1A]. On the other hand, maximum number of created simultaneously pions from energy equivalent to mass of a nucleon is 6 (6 pairs of loops). Simplest neutral pion consists of two gluons (they are the rotational energies of their carriers) and their carriers (they are the neutrino-antineutrino pairs; in fields without internal helicity, gluons transform into photons [1A]). On the other hand, due to the internal helicity of the nuclear strong fields and the gluons, in the nuclear strong fields, the two spin-1 loops a pion consists of behave as the electron-electron pairs in atoms i.e. states of such pairs in an atom must be different. For pions, such scenario is realized by different number of gluons (so of their carriers as well) in them. It means that each of the two loops a pion consists of is built of 4^{32} neutrino-antineutrino pairs (4^d, where $d = 1, 2, 4, 8, 16, 32$ i.e. the 6 different possibilities). Maximum number of entangled neutrinos or other objects is $2 \cdot 4^{32}$. Such symmetry we call the four-neutrino/particle/object symmetry. Such symmetry appears in SST many times. For example, the very early Universe was the binary system of loops each composed of $2 \cdot 4^{32}$ neutron black holes [1B]. The very early Universe produced the DM circles each composed of $2 \cdot 4^{32}$ neutrinos (more precisely of 4^{32} neutrino-antineutrino pairs). Their total mass was equal to the mass of the core of the Protoworld [1B].

Calculate the invariant mass of the DM circles (mass of the DM pions is two times higher)

$$M_{DM\text{-}circle} = 4^{32}\, m_{pair} = 1.23 \cdot 10^{-47}\ \text{kg}\,. \tag{1}$$

This mass is about 17 powers of ten lower than the mass of electron.

Calculate the lower limit for radius of DM circle composed of 4^{32} entangled pairs on an assumption that the lower limit for mean distance between the pairs in the DM circle is equal to the mean distance between the neutrino-antineutrino pairs in the Einstein spacetime i.e. is $L \approx 3.93 \cdot 10^{-32}$ m [1A]. It means that radius of such DM circle is

$$R_{DM\text{-}circle,lower\text{-}limit} = 4^{32}\, L\, /\, (\, 2\,\pi) = 1.15 \cdot 10^{-13}\ \text{m}\,. \tag{2}$$

Upper limit for size is arbitrary. There, for example, are in existence the cosmological DM rulers/loops with a radius of 151 Mpc [4].

3. Detection of the DM structures

Since the Einstein-spacetime components in the DM circles and DM pions do not rotate and their speed is invariant, we can detect them only indirectly or using detectors that can detect their very small mass. An Earth experiment should mimic the interactions of stars/BM with DM structures in spiral galaxies via leptons – there should appear a characteristic spin speed of spinning baryonic matter that is calculated within SST [5]. But due to very low mass of the DM circles, even indirect detection of DM structures is not an easy task.

Notice as well that angular momentum of DM circles that expand with a BM ring increases so of the BM ring must decrease. Maybe in such a way we can detect indirectly the DM circles.

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