Dynamics of the "Bullet Cluster" (Interactions of the Dark Matter)

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Abstract: Here, within the Scale-Symmetric Theory (SST), we analyse the internal interactions in the dark-matter structures and the weak interactions via leptons of the dark-matter structures entangled with the hadronic and leptonic matter.

1. Introduction

Within the Einstein General Theory of Relativity we obtain formula for the total energy of the Standard-Model particles i.e. for particle that inertial mass is equal to its gravitational mass (the Principle-of-Equivalence objects). Assume that the word "imaginary" concerns physical quantities characteristic for objects that have broken contact with the wave function that describes state of the Universe. This means that such objects cannot emit some particles so they should be the internally structureless objects i.e. they are some pieces of space carrying only the inertial mass (they are the non-gravitating objects). Substitute ic instead the speed of light in "vacuum" c, iv instead the kinetic speed v and im instead the gravitational mass M, where $i = sqrt(-1)$ is the imaginary unit. Then the formula for the total energy of a field composed of the non-gravitating pieces of space is

$$E = m\, c^2 / sqrt(v^2 / c^2 - 1). \quad (1)$$

We can see that now the non-gravitating pieces of space must be superluminal (v must be higher than the speed of light, c, in "vacuum") i.e. they are the non-gravitating tachyons. The field composed of non-gravitating tachyons we refer to as the Higgs field. It is the Higgs field which causes that non-gravitating objects, due to the interaction with the Higgs field, acquire their gravitational mass (the Higgs mechanism).

The Scale-Symmetric Theory (SST), [1], starts from the Higgs field composed of the non-gravitating tachyons. The new law of saturation of interactions via the Higgs field and the law of conservation of spin lead to the succeeding phase transitions of the Higgs field. Due to the phase transitions, we obtain different scales of size, energy and speed – it is the foundations of the SST.

We obtain five scales i.e. the Higgs-field-component superluminal scale associated with gravitational fields, the quantum-entanglement superluminal scale, the luminal Planck scale associated with the luminal Einstein-spacetime components (it leads to the internal structure and properties of neutrinos), the baryonic scale that leads to the atom-like structure of baryons (it leads to the internal structure and properties of electrons as well), and the cosmological scale that leads to the origin of the dark matter and dark energy and to the expanding Universe [1A], [1B].

The SST starts from 7 parameters and a few very simple symmetries only and is free from approximations, mathematical tricks and free parameters i.e. it is a unique theory. Within such a theory, we calculated a thousand results that are consistent or very close to experimental data.

The assumption that the two leading theories, i.e. the General Relativity (GR) and Quantum Physics (QP), are incomplete only is incorrect. There must be in existence a third fundamental theory that should lead to the initial conditions applied in GR and QP. The third fundamental theory should solve all the unsolved fundamental problems. And within the SST we can do it. The SST shows that unification of GR and QP within the same methods is impossible (the gravitational fields are the gradients in the superluminal non-gravitating Higgs field produced by the luminal Einstein-spacetime components, whereas the Standard-Model interactions are associated with the superluminal quantum entanglement and with the luminal gravitating Einstein-spacetime; the Standard-Model particles consist of entangled and/or confined Einstein-spacetime components and neutrinos). We can unify the GR and QP partially only via the succeeding phase transitions that lead to the different scales.

Within SST we can show, for example, how the luminal gravitating Einstein-spacetime components (they are built of the superluminal entanglons responsible for the quantum entanglement) produce the superluminal gravitational fields.

2. Interactions of the dark matter

According to SST, both dark-matter particle and dark-energy particle are the luminal Einstein-spacetime components i.e. the neutrino-antineutrino pairs [2], [1B]. They appeared due to the evolution of the cosmological-object/Protoworld that existence follows from the succeeding phase transitions of the Higgs field [1A], [1B]. The dark energy consists of the free additional Einstein-spacetime components (they interact gravitationally only) whereas the dark-matter structures consist of entangled neutrino-antineutrino pairs and they interact with hadronic and leptonic matter via the weak interactions of leptons [3].

Coupling constant for the pure directional quantum entanglement is

$$\alpha_E = 3.1 \cdot 10^{92},$$ [1A],

whereas coupling constant for the weak interactions via leptons of the dark-matter structures with hadrons and leptons is

$$\alpha_{W(\text{electron-muon})} = 9.511 \cdot 10^{-7}$$ [1A], [3],

i.e. the directional superluminal quantum entanglement is much stronger than the weak interactions via leptons.

It causes that during a collision of two clusters (as, for example, the "Bullet Cluster") the dark-matter structures pass through the collision practically without a change in their distribution – the weak interactions are too weak the colliding baryonic and leptonic matter could entail the dark matter. Just the entangled structures in dark matter are much more stable than the mixed structures of dark and visible matter that follow from the weak interactions via leptons.

Since the Einstein-spacetime component, the dark-matter particle and the dark-energy particle all are the neutrino-antineutrino pairs, [1B], [2], so the dark-matter structures expand together with the Universe. Of course, the intensity of the directional quantum entanglement depends on distance (frequency of rotation of the exchanged entanglons is inversely proportional to distance between entangled particles). But we must emphasize that there is the very strong shortest-distances entanglement for distances in approximation $2.3 \cdot 10^{-35}$ m and $7.0 \cdot 10^{-35}$ m that are close to the Planck length [1A]. It causes that the electric charge of proton is the very stable structure [1A].

The dark energy is distributed in the Universe much more uniformly than the dark matter which is closer to hadronic matter. It causes that the dark matter had a greater impact on the expansion of the protogalaxies (according to the SST, protogalaxy formation had already occurred before the expansion of the Universe (i.e. before the "soft" big bang which was separated in time from the inflation i.e. from the big bang [1B]).

Emphasize as well that SST shows that detection of the neutrino-antineutrino pairs is much difficult than detection of free neutrinos. It follows from the fact that the resultant weak charge of a free neutrino-antineutrino pair is equal to zero so they interact gravitationally only. Sometimes they can interact via directional quantum entanglement and via volumetric confinement which follows from the Mexican-hat mechanism (it is the very short-distance interaction; range is about $4 \cdot 10^{-32}$ m [1A]).

References

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