Quantization of Masses of Galaxy Clusters

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Abstract: It is partially a review paper. Here we have focused on creation and large-scale evolution of the Universe which are described mathematically in the cited papers. We recalled it because then the quantization of masses of galaxy associations is more understandable. Here, applying the Scale-Symmetric Theory (SST), we showed the origin of quantization of the total masses (dark matter plus baryonic matter) of the superclusters, clusters and groups of galaxies. Here we can find a statistical picture that leads to peaks in the mass function. SST shows that contrary to the nearby superclusters, the smaller parts in the distant superclusters (i.e. the clusters and groups) should be and are less isolated so the mainstream cosmology needs a revision because there was the evolution from the heavier structures to lighter structures, not from lighter to heavier. Masses of the galaxy superclusters should not change with time but with time in superclusters should appear clearly separated clusters and groups of galaxies.

1. Introduction

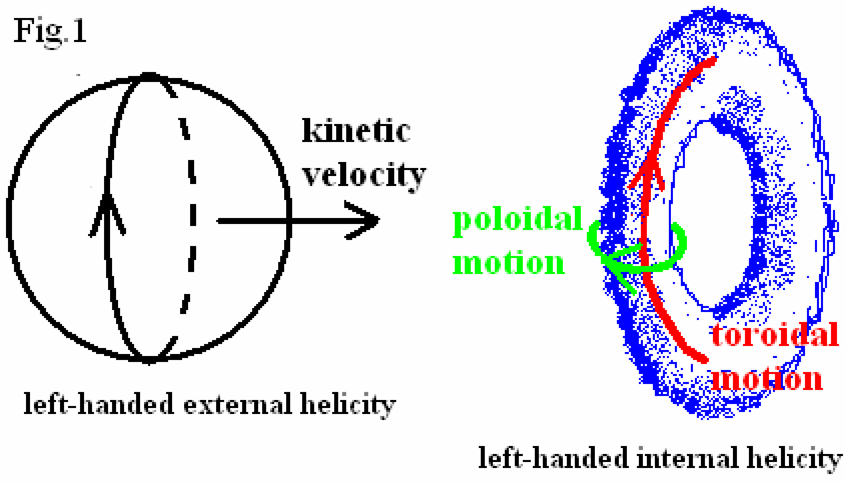
It is partially a review paper. Here we have focused on creation and large-scale evolution of the Universe which are described mathematically in the cited papers. We recalled it because then the quantization of masses of galaxy associations is more understandable.

Consistent physical description of a dynamics of some phenomena should be the essence of each theory. Only then applying mathematics we can test such a description and check its compliance with the experimental data.

Simple extension of the Special Relativity (SR) energy-momentum relation leads to the non-gravitating (imaginary) tachyons [1]. Natural speed of such tachyons in the truly-empty, very-large volumes/holes (their size can be as large as, say, 10^{100} m and more) created by tearing the internally structureless/non-transparent space (i.e. such holes have a timeless spatial boundary) increases with decreasing size of them [1]. A tachyon, due to its dynamic viscosity that results from smoothness of its surface, acts as a vacuum cleaner i.e. there can be created big and very big pieces of space (their size can be as large as, say, 10^{10} m and more) composed of tachyons packed to maximum of very small sizes (their size can be as small as, say, 10^{-50} m and less). The big pieces of space composed of the non-gravitating tachyons, due to their collisions, can have angular momentum – to conserve their angular momentum, their axis of rotation should overlap with their velocity i.e. they have the external helicity (Fig.1) [2].

Our Cosmos was created due to collision of a faster big piece of space (i.e. composed of smaller tachyons) with much bigger but slower one (i.e. composed of bigger tachyons). The external left-handedness of the smaller big piece of space transformed inside the bigger one into the left-handed internal helicity of the expanding Higgs field composed of the smaller tachyons (Fig.1) – it was the inflation field [1]. The Kasner solution to Einstein's theory of general relativity concerns the non-gravitating matter in an anisotropic universe. We interpret such solution (i.e. the solution $(2/3,\ 2/3,\ -1/3)$) as an expanding or shrinking torus (with internal helicity) composed of the non-gravitating tachyons [3].

Fig.1



During the very short inflation [4], there took place the succeeding phase transitions that transformed almost whole Higgs field (HF) into the gravitating Einstein spacetime (ES) composed of the neutrino-antineutrino pairs [1]. The ES took over almost whole the internal helicity of the expanding Higgs-field/inflation-field i.e. there was created a left-handed torus in the ES (notice that torus is the simplest object that can have internal helicity). For some critical radius of the expanding only during the very short inflation our Cosmos (it is about $2.3 \cdot 10^{30}$ m [5]), gravitational pressure in ES became higher than the dynamic pressure. When the radius of the front of the expanding HF and ES had become greater than that of the critical radius, the outer shell of ES collapsed so there was created a stable boundary of the ES [6]. On the other hand, the bigger tachyons created a stable boundary for the residual Higgs field [6]. The two boundaries and the very high dynamic pressure in HF and ES cause that practically the two fields in our Cosmos are flat – there can be created only infinitesimal fluctuations in ES that can transform into the massive particles or only "shallow" gradients in HF i.e. the gravitational fields [1]. The infinitesimal fluctuations in densities of HF and ES cause that the physical constants in our Universe are, practically, the invariants – just the ground state of the two-component spacetime cannot expand – there can expand the dark energy (DE) composed of the additional ES components but its density is today about 10^{55} times lower than the ground state of the ES – of course, we cannot distinguish the ES and DE components (dark energy was created due to decay of a virtual field) [6].

The collapse of the outer shell of ES created a return shock wave in ES that in the centre of our Cosmos created the Protoworld with left-handed internal helicity – it was due to the left-handed external helicity of the initial inflation-field/Higgs-field (Fig.1) [1], [6]. How should look the Protoworld? Nature suggests that it should be a quasar-like object [6] i.e. there should be a cosmological torus with supermassive black hole in its centre and outside it there should be a flat ring.

The gravitational field of the cosmological torus of the Protoworld thickened baryonic matter along two left-handed loops spinning in opposite directions inside the torus [6]. According to the Scale-Symmetric Theory (SST), analogous phenomena take place in cores of baryons [1], [6]. For example, neutral pions are created inside the torus in the cores of baryons – they are the two left-handed loops (composed of entangled the ES components) spinning in opposite directions to conserve the spin and electric charge of the torus [1].

The internal helicity of tori distinguish the bare fermions (the left-handed internal helicity is characteristic for, for example, neutrons, protons and positrons) from the bare antifermions (the right-handed internal helicity is characteristic for, for example, antineutrons, antiprotons and electrons) [1]. The internal left-handedness of the Protoworld, which followed from the initial external left-handedness of the inflation-field/Higgs-field, caused that it was composed of nucleons – such is the origin of the matter-antimatter asymmetry in the Universe. Emphasize that more nucleons than antinucleons were created already during the collapse of the outer shell of ES.

The thickened baryonic matter (along the two loops) transformed into the entangled protogalaxies composed of the entangled neutron black holes (NBHs) [6] – it was the very early Universe. Baryonic mass of the Universe is quantized and is $2 \cdot 2 \cdot 4^{32}$ NBHs = 4^{33} NBHs [6]. SST shows that the very strong short-distance quantum entanglement between the carriers of gluons in nucleons (i.e. between the ES components) protects the cores of nucleons from a collapse to a singularity [1]. It leads to conclusion that the black holes (BHs) consist of the neutron black holes (NBHs) and each NBH has mass $f = 24.81$ times greater than the Sun i.e. $M_{NBH} = f\ M_{Sun}$ [6]. It leads to conclusion that the quantized baryonic mass of the Universe is $M_{B,Universe} = 1.831 \cdot 10^{21} M_{Sun}$.

The saturation of interactions via the entanglons causes that if smaller structure is built of N parts then the next bigger one is built of N^2 parts [6] – it leads to the four-object symmetry. Due to the four-object symmetry, NBHs were and partially still are grouped in larger structures [6]. Number of entangled objects in a system is quantized [6]

$$D_{n,S} = 4^d \text{ (for single objects),} \tag{1a}$$

$$D_{n,B} = 2 \cdot 4^d \text{ (for binary systems),} \tag{1b}$$

where for flat/disc-like structures is $d = 0, 1, 2, 4, 8, 16 \ldots = 0, 2^n$, where $n = 0, 1, 2, 3, 4, 5, \ldots$ whereas for chains is $d = 3, 6, 12$ [6].

When gravity dominates then the associations containing smallest number of objects (of course apart from the trivial case $d = 0$) appear most often. Since pairing of cosmological objects is common so very important are objects containing four binary systems – from (1b) we obtain $D_{n=1,B,Typical} = 2 \cdot 4^1 = 8$ constituents. Especially it concerns decays of the most massive superclusters. Mass of each protogalaxy was $M_{Protogalaxy} = 4^{16}\ f\ M_{Sun} = 1.0656 \cdot 10^{11}\ M_{Sun}$ [6].

The above remarks suggest that initially the typical baryonic mass of massive disc galaxy was [7]

$$M_{Initial} = 8\ M_{Protogalaxy} = 2 \cdot 4^{17}\ f\ M_{Sun} = 8.5247 \cdot 10^{11}\ M_{Sun}\ . \tag{2}$$

Emphasize that there were 8 seeds.

The four-object symmetry leads to the quantized baryonic masses of the dwarf disc galaxies and globular clusters [8] – obtained results are consistent with observational facts [9], [10].

Due to a phase transition of the cosmological torus and the central black hole of the Protoworld described within SST [6], they transformed into dark matter (DM) i.e. into the structures composed of entangled the ES components that were and still are entangled with baryonic matter [6]. Calculated mass of all DM structures is $F = 5.389$ times higher than the baryonic matter i.e. the total mass (BM + DM) of the Universe is

$$M_{Total,Universe} = (1 + F)\, M_{B,Universe} = 1.170 \cdot 10^{22}\, M_{Sun}. \quad (3)$$

The inflows of dark matter and, next, of dark energy into the early Universe started its expansion and the succeeding decays. Due to the return shock wave, the expansion of the Universe and, next, the reflecting of the expanding baryonic matter from the boundary of the ES, the evolution of the Universe in our Cosmos is cyclic.

2. Quantization of total masses of superclusters, clusters and groups of galaxies

The inflows of dark matter and next of dark energy into the very early Universe caused that each of the two loops decayed to 4^8 parts. It leads to conclusion that in the mass function there should be a peak associated with the most massive superclusters (SC)

$$M_{SC,maximum} = M_{Total,Universe} / (2 \cdot 4^8) = 0.89 \cdot 10^{17}\, M_{Sun}. \quad (4)$$

Next, there were the successive decays to 4 or 8 parts so we should observe peaks for following total masses

$$M_{Clusters,\mathrm{n}=0,1,2,3,4,5,6} = M_{SC,maximum} / 4^{\mathrm{n}}\,. \quad (5a)$$

$$M^*_{Clusters,\mathrm{n}=0,1,2,3,4} = M_{SC,maximum} / 8^{\mathrm{n}}\,. \quad (5b)$$

From (5a) we obtain
$M_{Supercluster,\mathrm{n}=0} = 0.89 \cdot 10^{17}\, M_{Sun}$,
$M_{Supercluster,\mathrm{n}=1} = 2.2 \cdot 10^{16}\, M_{Sun}$,
$M_{Supercluster,\mathrm{n}=2} = 5.6 \cdot 10^{15}\, M_{Sun}$,
$M_{Supercluster,\mathrm{n}=3} = 1.4 \cdot 10^{15}\, M_{Sun}$,
$M_{Cluster,\mathrm{n}=4} = 3.5 \cdot 10^{14}\, M_{Sun}$,
$M_{Cluster,\mathrm{n}=5} = 0.9 \cdot 10^{14}\, M_{Sun}$,
$M_{Group,\mathrm{n}=6} = 2.2 \cdot 10^{13}\, M_{Sun}$.

From (5b) we obtain
$M^*_{Supercluster,\mathrm{n}=0} = 0.89 \cdot 10^{17}\, M_{Sun}$,
$M^*_{Supercluster,\mathrm{n}=1} = 1.1 \cdot 10^{16}\, M_{Sun}$,
$M^*_{Supercluster,\mathrm{n}=2} = 1.4 \cdot 10^{15}\, M_{Sun}$,
$M^*_{Cluster,\mathrm{n}=3} = 1.7 \cdot 10^{14}\, M_{Sun}$,
$M^*_{Group,\mathrm{n}=4} = 2.2 \cdot 10^{13}\, M_{Sun}$.

We can see that $M_{Supercluster,\mathrm{n}=0} = M^*_{Supercluster,\mathrm{n}=0}$, $M_{Supercluster,\mathrm{n}=3} = M^*_{Supercluster,\mathrm{n}=2}$, and $M_{Group,\mathrm{n}=6} = M^*_{Group,\mathrm{n}=4}$.

3. Summary

In this paper, applying the Scale-Symmetric Theory (SST), we showed the origin of quantization of the total masses (dark matter plus baryonic matter) of the superclusters, clusters and groups of galaxies.

SST shows that contrary to the nearby superclusters, the smaller parts in the distant superclusters (i.e. the clusters and groups) should be and are less isolated so the mainstream cosmology needs a revision because there was the evolution from the heavier structures to lighter structures, not from lighter to heavier. For example, the dwarf galaxies appeared due to explosions of the protogalaxies whereas masses of the galaxy superclusters should not change with time but with time in superclusters should appear clearly separated clusters and groups of galaxies.

SST shows that the GR and Quantum Mechanics (QM) are the theories of observer, not of Nature.

For example, SST shows that due to the quantum entanglement between photons and their sources, the speed of light in "vacuum" c is the speed in relation to source or a last-interaction object. Moreover, sources can have radial velocities in relation to detectors of photons – it causes that effects depend on behaviour of chosen frame of reference – for detectors, the c is an invariant as it is in GR but for Nature it is not true! SST shows as well that the relativistic mass is real whereas the Lorentz contraction is invalid for the cores of baryons. SST shows that we can derive whole physics from properties of the initial inflation field. Of course, we can neglect the superluminal gravitational fields and the superluminal quantum entanglement (SST shows that we can start, for example, from the 4 basic physical constants i.e. G, c, e, and $\hbar$, and 3 masses i.e. the mass of electron and the masses of the neutral and charged pions [1]) but then gravity, quantum entanglement, and structure of the bare fermions are not well understood.

On the other hand, the superluminal quantum entanglement, which cannot be controlled, causes that there appear the wave functions and probabilities but SST shows that in reality Nature behaves classically i.e. the all free and bound tachyons whole Nature is built of have the real trajectories.

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