The Dark-Matter Mechanism and Orbital Speeds of Stars in Galaxies

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Abstract: Here, within the Scale-Symmetric Theory (SST), we described the dark-matter mechanism which leads to the equality of orbital speeds of stars outside the central stellar bulge of spiral galaxy. The obtained results are consistent with the observational facts for the Milky Way, Andromeda Galaxy, Triangular Galaxy and SBO-a NGC 4984. The equality of orbital speeds of stars for defined spiral galaxy follows from the weak interactions, via leptons, of the baryonic matter with the virtual dark-matter loops in the Einstein spacetime - the loops mimic the motions in fermions. The ordered motions of matter along the jets of quasars produce flows in the Einstein spacetime. Such motions decrease local dynamic pressure in the spacetime i.e. there are produced pressure holes. To increase the lowered dynamic pressure, there are inflows of additional Einstein-spacetime components into the pressure holes but mass density is still to low to produce real particles. Such regions with higher local mass density of the Einstein spacetime mimic gravitational attraction so there appears the gravitational lensing. During the initial period of evolution of quasars, the iron-plus-nickel lumps from the explosions of the Population III supernovae (the first-generation big stars) mainly collected in the regions with higher local mass density of the Einstein spacetime so there appeared the ferromagnetic filaments between the quasars. We do not need some exotic matter to explain the origin of dark matter and dark energy - they both are the additional entangled or free neutrino-antineutrino pairs (the free pairs interact gravitationally only). We calculated as well the “mass ratio” of the dark matter and visible matter for galaxies, dwarf-galaxies and ultra-faint galaxies (dSphs). For the dwarf galaxies with active dark-matter mechanism, the ratio is up to 1000 and more.

1. Introduction

The General Relativity leads to the non-gravitating Higgs field composed of tachyons [1A]. On the other hand, the Scale-Symmetric Theory (SST) shows that the succeeding phase transitions of such Higgs field lead to the different scales of sizes [1A]. Due to the saturation of interactions via the Higgs field and due to the law of conservation of the half-integral spin that is obligatory for all scales, there consequently appear the superluminal binary systems of closed strings (entanglons) responsible for the quantum entanglement (it is the quantum-entanglement scale), stable neutrinos and luminal neutrino-antineutrino pairs which are the components of the luminal Einstein spacetime (it is the Planck scale), cores of baryons (it is the electric-charges scale), and the cosmic structures (protoworlds; it is the cosmological scale) that evolution leads to the dark matter, dark energy and expanding universes (the “soft” big bangs) [1A], [1B]. The non-gravitating tachyons have infinitesimal spin so all listed structures have internal helicity (helicities) which distinguishes particles from their antiparticles [1A]. SST shows that a fundamental theory should start from infinite nothingness and pieces of space [1A]. Sizes of pieces of space depend on their velocities [1A]. The inflation field started as the liquid-like field composed of non-gravitating pieces of space [1A]. Cosmoses composed of universes are created because of collisions of big pieces of space [1A], [1B]. During the inflation, the liquid-like inflation field (the non-gravitating superluminal Higgs field) transformed partially into the luminal Einstein spacetime (the big bang) [1A], [1B]. In our Cosmos, the two-component spacetime is surrounded by timeless wall – it causes that the fundamental constants are invariant [1A], [1B].

Due to the symmetrical decays of bosons on the equator of the core of baryons, there appears the atom-like structure of baryons described by the Titius-Bode orbits for the nuclear strong interactions [1A].

Applying 7 parameters only and a few new symmetries we calculated a thousand of basic physical (and mathematical) quantities (there are derived the physical and mathematical constants as well) consistent or very close to experimental data and observational facts (http://vixra.org/author/sylwester_kornowski). In SST there do not appear approximations, mathematical tricks, and free parameters which are characteristic for the mainstream particle physics and mainstream cosmology.

The total weak charge of each Einstein-spacetime component (i.e. of neutrino-antineutrino pair) is equal to zero so its detection is much more difficult than the neutrinos.

Phenomena concerning the cosmological scale lead to the dark matter – it consists of the additional Einstein-spacetime components entangled with baryonic matter and other gravitating particles [1B].

Rotating or moving baryonic plasma can create the virtual dark-matter loops/strings composed of entangled neutrino-antineutrino pairs – they are the dark-matter structures. Due to the expansion of the Universe, size of the dark-matter loops increases – it follows from the properties of the quantum entanglement [1A]. The radii of the loops increased significantly and today the loops are as well in the halos of galaxies. Centres of such loops, first of all, overlap with the centres of galaxies. Since such loops consist of the luminal Einstein-spacetime components so the orbital speeds are equal to the speed of light in “vacuum” c.

2. The dark-matter mechanism and orbital speeds of stars in spiral galaxies

Due to the weak interactions of the virtual dark-matter loops (they are produced in the Einstein spacetime by baryonic plasma) with baryonic matter (via leptons), there appears the advection i.e. the stars outside the central stellar bulge acquire their orbital speeds around the centres of spiral galaxies.

There dominates the mass of the central bulge so from formula

$$v^2 = G\, m / r \qquad (1)$$

follows that orbital speed v is directly proportional to square root from observed mass of a spiral galaxy: $v \sim sqrt(m_{galaxy,visible})$.

The mass of a galaxy responsible for the weak interactions via the leptons is αm_{galaxy}, where α is the coupling constant. This coupling constant is calculated within SST [1A]

$$\alpha_{w(electron\text{-}muon)} = 9.511082 \cdot 10^{-7}. \qquad (2)$$

This value is for two interacting particles but there is obligatory the four-particle/object symmetry, [1A], [1B], so coupling constant for a quadrupole is $2\alpha_{w(electron\text{-}muon)}$.

Now we can write the formula for the orbital speeds of stars outside the central bulge that follow from the loop-matter advection

$$v_{orbital\text{-}speed,advection} = c\,(2\alpha_{w(electron\text{-}muon)}\, m_{galaxy,visible} / m_{o,MBH})^{1/2} = const., \qquad (3)$$

where $m_{o,MBH}$ is mass of the modified black hole (MBH) from which the galaxy evolved because of the inflows of dark matter and dark energy.

SST shows that the MBHs consist of the modified neutron black holes (MNBHs) [1B]. SST shows that in black holes there is not a central singularity but there is a circular orbit with spin speed equal to the speed of light in "vacuum" c. The c in formula (3) represents both the spin speed on the circular orbit of the initial MBH and the spin speed of the neutrino-antineutrino pairs in the virtual dark-matter structures that due to the advection carry the stars.

SST shows that initial mass of typical massive spiral galaxy was $m_{o,MBH,S} = 2M_{Protogalaxy} \approx 2.131 \cdot 10^{11}\, M_{Sun}$ [2], [1B]. Due to the initial Double Cosmic Loop, [1B], the upper limit for initial mass of massive spiral galaxy was two times greater i.e. $m_{o,MBH,spiral,upper} = 2m_{o,MBH,S} \approx 4.262 \cdot 10^{11}\, M_{Sun}$ so the upper limit for massive barred spiral galaxy was $m_{o,MBH,mean,barred} \approx 8.5 \cdot 10^{11}\, M_{Sun}$. Mass of typical massive elliptical galaxy was $m_{o,MBH,E} = 16M_{Protogalaxy} \approx 1.705 \cdot 10^{12}\, M_{Sun}$ (a merger of two groups each containing four binary systems of protogalaxies) i.e. was 8 times bigger than mass of typical massive spiral galaxy.

Calculate the orbital speeds of stars for the upper limit for visible mass of massive spiral galaxies, for the Andromeda Galaxy (M31, NGC 224) at the assumption that its visible mass is $m_{M31} = 3.6 \cdot 10^{11}\, M_{Sun}$ (this mass is about 4 times smaller than mass estimated for the Andromeda Galaxy's halo (including dark matter): $1.5^{+0.5}_{-0.4} \cdot 10^{12}$ solar masses [3]), for the Milky Way at the assumption that its visible mass is $m_{MW} = 0.8m_{M31} \approx 2.9 \cdot 10^{11}\, M_{Sun}$ and for the Triangulum Galaxy (M33, NGC 598) at the assumption that its visible mass is $m_{M33} = 1.0 \cdot 10^{11}\, M_{Sun}$.

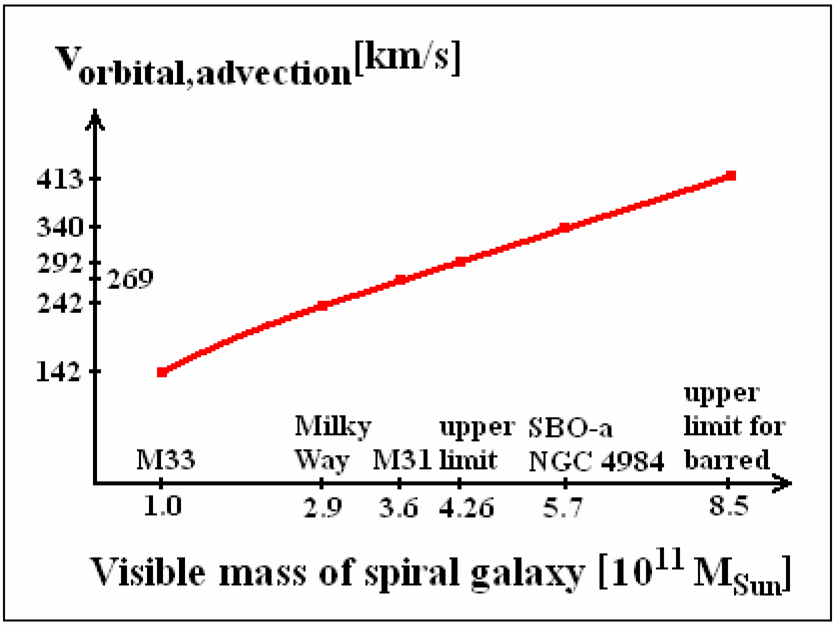
Applying formula (3) we obtain:
$v_{orbital\text{-}speed,advection,o} = 292$ km/s,
$v_{orbital\text{-}speed,advection,M31} = 269$ km/s,
$v_{orbital\text{-}speed,advection,MW} = 242$ km/s,
$v_{orbital\text{-}speed,advection,M33} = 142$ km/s.

The obtained results are consistent with observational facts and are collected in Fig.

Notice that from formula (3) follows that for barred spiral galaxies is

$$v_{max\text{-}orbital\text{-}speed,advection,barred} = sqrt(2)\, v_{max\text{-}orbital\text{-}speed,advection}. \qquad (4)$$

Formula (4) leads to conclusion that maximum orbital speed for barred spiral galaxies is 413 km/s. For barred spiral galaxy SBO-a NGC 4984 is $v_{orbital\text{-}speed,advection,barred} \approx 340$ km/s so this result is consistent with presented here theory of dark matter.



The ordered motions of baryonic plasma along the jets of quasars produced flows in the Einstein spacetime. Such motions decrease local dynamic pressure in the spacetime i.e. there are produced pressure holes. To increase the lowered dynamic pressure, there were inflows of additional Einstein-spacetime components into the pressure holes but mass density of the Einstein spacetime still was too low to produce quantum entanglement and confinement of the neutrino-antineutrino pairs which is needed to create real particles [1A]. Such regions with higher local mass density of the Einstein spacetime mimic gravitational attraction so there appears the gravitational lensing. During the initial period of evolution of quasars, the iron-plus-nickel lumps from the explosions of the Population III supernovae (the first-generation big stars) mainly collected in the regions with higher local mass density of the Einstein spacetime so there appeared the ferromagnetic filaments between the quasars.

We do not need some exotic matter to explain the origin of dark matter and dark energy.

3. "Mass ratio" of the dark matter and visible matter for galaxies, dwarf-galaxies and ultra-faint galaxies (dSphs)

According to SST, due to the four-object symmetry, there appeared the MBHs containing following number of binary systems of the MNBHs [1B]

$$N_d = 4^d, \tag{5a}$$

$$m_{o,MBH,d} = 4^d\, M_{MNBH} = 2\, f\, 4^d\, M_{Sun}\,, \tag{5b}$$

where d = 0, 1, 2, 4, 8, 16 or 3, 6, (9 = 3 + 6), 12 whereas f = 24.81.

Assume that the calculated from formula (3) orbital speeds of stars follow from presence of the dark matter (we showed that mainly it follows from the weak interactions of the dark-matter structures with baryonic matter via leptons)

$$v_{orbital\text{-}speed,advection}{}^2 = G\, M_{Dark\text{-}Matter} / r_{galaxy}\,. \tag{6}$$

Applying formulae (3), (5b) and (6) we obtain

$$R_{DM\,/\,V} = M_{Dark\text{-}Matter} \,/\, m_{galaxy,visible} = (2\alpha_{w(electron\text{-}muon)}\, c^2 / G)\, r_{galaxy} / m_{o,MBH,d} = \\ = F\, r_{galaxy} / m_{o,MBH,d}\,, \quad (7a)$$

$$R_{DM\,/\,V} = F\, r_{galaxy} / (2\, f\, 4^d\, M_{Sun}), \quad (7b)$$

where $F = 2.5616 \cdot 10^{21}$ kg / m = $1.22 \cdot 10^7\, M_{Sun}$ / ly.

For Milky Way is $r_{galaxy} \approx 80{,}000$ ly and was $m_{o,MBH,spiral} \approx 2.131 \cdot 10^{11}\, M_{Sun}$ ($d = 16$) so from formula (7a) we obtain $R_{DM\,/\,V} \approx 4.6$.

Mass of typical dwarf galaxy within 1000 ly is about $1.3 \cdot 10^7\, M_{Sun}$ ($d = 9$), [4], so applying formula (7a) we obtain $R_{DM\,/\,V} \approx 940$. For the ultra-faint galaxies (dSphs) it should be even more.

We must emphasize once more that it is not true that in the dwarf galaxies there is from 100 to 1000 times more dark matter than visible matter. Such high ratios follow from the dark-matter mechanism that is associated with the virtual dark-matter structures. The Scale-Symmetric theory shows that in reality the mass ratio of whole dark matter and whole visible matter is about 5.4 [1B].

4. Summary

Here, within the Scale-Symmetric Theory (SST), we described the dark-matter mechanism which leads to the equality of orbital speeds of stars outside the central stellar bulge of spiral galaxy. The obtained results are consistent with the observational facts for the Milky Way, Andromeda Galaxy, Triangular Galaxy and SBO-a NGC 4984. The equality of orbital speeds of stars for defined spiral galaxy follows from the weak interactions, via leptons, of the baryonic matter with the virtual dark-matter loops in the Einstein spacetime – the loops mimic the motions in fermions.

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