The Dark-Matter Mechanism and Spin Speeds of Stars in Spiral Galaxies

Sylwester Kornowski

Abstract: Here, within the Scale-Symmetric Theory (S-ST), we described the dark-matter mechanism which leads to the equality of spin 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 spin speeds of stars for defined spiral galaxy follows from the weak interactions, via leptons, of the baryonic matter with virtual 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.

1. Introduction

The Scale-Symmetric Theory (S-ST) [1], [2], [3] starts from expanding liquid composed of the non-gravitating, non-relativistic, superluminal pieces of space (tachyons) – it is the big bang. The gas composed of the tachyons is the modified Higgs field. The abbreviation S-ST we can interpret as well as the super-set i.e. the set composed of following elements denoting numbers of tachyons in bigger and bigger structures: 1, K^2, K^4, K^8, K^{16}, where $K = 0.7896685548 \cdot 10^{10}$.

To the modified Higgs field we can apply the Kasner metric [4] that is a solution to the vacuum Einstein equations. The Kasner solutions we interpret as the virtual tori/cyclones and one-dimensional virtual oscillations which lead to virtual loops in the modified Higgs field [1], [2].

To quantize the sizes of the virtual Higgs cyclones we need additional conditions that lead as well to the four succeeding phase transitions of the modified Higgs field [2]. They are as follows (the three additional laws of conservation).

1. The saturation of interactions via collisions of the tachyons: if a smallest structure consists of K^2 tachyons (it is a closed string which can appear in the maximum dense modified Higgs field i.e. in the liquid-like field; its inertial spin is half-integral) then the bigger structures consist of respectively K^4, K^8 and K^{16} pieces of space (due to the size of our Cosmos, bigger structures do not appear [5]).

2. Mean surface densities of all structures should have the same value – then Nature immediately repairs any damages to such structures.

3. Due to the conservation of the half-integral spin, all structures appearing due to the succeeding phase transitions of the modified Higgs field should have such spin.

Due to the four succeeding phase transitions, there are in existence the four scales i.e. the superluminal-quantum-entanglement scale, luminal Planck scale concerning the Einstein-spacetime components, observed-particles scale and cosmological scale [2].

The Einstein-spacetime components are the neutrino-antineutrino pairs [2]. Their total weak charge is equal to zero so their 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 [2].

Due to the quantum entanglement of the Einstein-spacetime components and internal structure of bare fermions, in the Einstein spacetime inside fermions are produced virtual loops [2]. Such loops were produced as well in the rotating protogalaxies which were the very dense objects [2]. Due to the inflows of dark matter into the protogalaxies [2], 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 spin speeds are equal to the speed of light in “vacuum” c.

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

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

There dominates the mass of the central bulge so from formula

$$v^2 = Gm / r \qquad (1)$$

follows that spin speed v is directly proportional to square root from luminal mass of a spiral galaxy: $v \sim \mathrm{sqrt}(m_{galaxy})$.

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 S-ST ([2], formula (56))

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

This value is for two interacting particles ([2]: see formulae (77) and (78)) but there is obligatory the four-particle/object symmetry, [2], so coupling constant for a quadrupole is $2\alpha_{w(electron\text{-}muon)}$.

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

$$v_{spin\text{-}speed,advection} = c\ \mathrm{sqrt}(2\alpha_{w(electron\text{-}muon)}\ m_{galaxy} / m_o) = \mathrm{const.}, \qquad (3)$$

where $m_o = 4\cdot(2M_{Protogalaxy}) \approx 8.5\cdot 10^{11}\ M_{Sun}$ is the upper limit for luminal mass of massive elliptical galaxies (a symmetrical merger of four binary systems of protogalaxies [2]). The upper limit for luminal mass of massive spiral galaxy is $m_o/2 = 2\cdot(2M_{Protogalaxy}) \approx 4.26\cdot 10^{11}\ M_{Sun}$.

Calculate the spin speeds of stars for the upper limit for luminal mass of massive spiral galaxies, for the Andromeda Galaxy (M31, NGC 224) at the assumption that its luminal 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 [6]), for the Milky Way at the assumption that its luminal mass is $m_{MW} = 0.8\cdot m_{M31} \approx 2.9\cdot 10^{11}\ M_{Sun}$ and for the Triangulum Galaxy (M33, NGC 598) at the assumption that its luminal mass is $m_{M33} = 1.0\cdot 10^{11}\ M_{Sun}$.

Applying formula (3) we obtain:

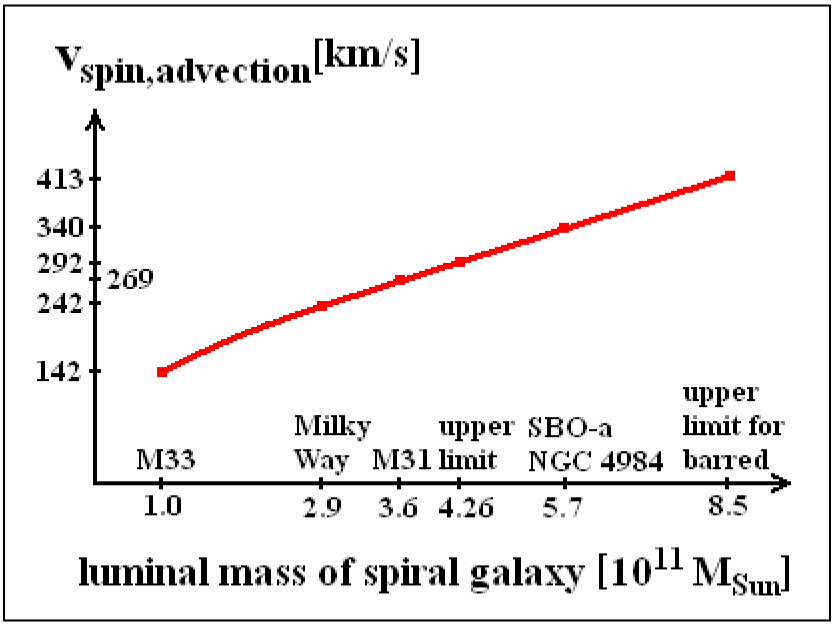
$v_{spin-speed,advection,o} = 292$ km/s,

$v_{spin-speed,advection,M31} = 269$ km/s,

$v_{spin-speed,advection,MW} = 242$ km/s,

$v_{spin-speed,advection,M33} = 142$ 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

$$v_{max-spin-speed,advection,barred} = sqrt(2)\ v_{max-spin-speed,advection}. \quad (4)$$

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

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.

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3. Summary

Here, within the Scale-Symmetric Theory (S-ST), we described the dark-matter mechanism which leads to the equality of spin 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 spin speeds of stars for defined spiral galaxy follows from the weak interactions, via leptons, of the baryonic matter with virtual loops in the Einstein spacetime - the loops mimic the motions in fermions.

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