# Foundations of the Scale-Symmetric Physics

# (Main Article No 3: Chaos Theory)

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**Abstract:** Here, applying the Scale-Symmetric Theory (SST), we show how particle physics via the Chaos Theory leads to the cosmological dark-matter structures and mental solitons. Moreover, the interactions of the cosmological dark-matter structures with baryonic matter via weak interactions of leptons, lead to the untypical motions of stars in galaxies and to other cosmological structures such as AGN composed of a torus and a central-condensate/modified-black-hole or solar system. Most important in the Chaos Theory (ChT) is to understand physical meaning of a logistic map for the baryons - it concerns the black-body spectrum and the ratio of the masses of charged kaon and pion. Such logistic map leads to the first Feigenbaum constant related to the period-doubling bifurcations that in a limit lead to the onset of chaos. In the period-doubling bifurcations for proton there appear the orbits of period-4 and higher periods. We show that the orbits of period-4 follow from the structure of baryons and that they lead to the Titius-Bode law for the nuclear strong interactions. Calculated here on base of the structure of proton the first Feigenbaum constant is 4.6692033 and it is close to the mathematical value 4.6692016…

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**1. Introduction**

Chaotic behaviour arises in simple non-linear dynamical systems.

The Logistic Map is written as follows

$$x_{n+1} = r\, x_n\, (1 - x_n), \tag{1}$$

where $x_n$ is a number between zero and one (the interval [0, 1]) that represents the ratio of existing population to the maximum possible population, whereas $r$ is a parameter. It leads to conclusion that $r$ is defined by the interval [0, 4]. There are many different logistic maps that in the limit behave the same – it is the Feigenbaum universality. Such maps describe many physical phenomena. Such maps have a similar shape i.e. have a single quadratic maximum. The parameter $r$ defines steepness of the maximum.

The Logistic Map is discussed in many references [1], [2], [3], [4], and so on, but a very complete discussion is given in [5].

A single bifurcation is a splitting of one value into two values. Such bifurcations appear in the Logistic Map for different values of the parameter $r$. We let $r_n$ be the value of $r$ at which a stable $2^n$ cycle first appears. At $r = r_1 = 3$ there is a splitting of one a branch into two i.e. there appears an orbit of period $2^1 = 2$, at $r = r_2 \approx 3.4494897\ldots$ there is a splitting of two branches into four (each branch splits into two) i.e. there appears an orbit of period $2^2 = 4$, at $r = r_3 \approx 3.54409\ldots$ there is a splitting of four branches into eight (each branch splits into two) i.e. there appears an orbit of period $2^3 = 8$, at $r = r_4 \approx 3.5644\ldots$ there is a splitting of eight branches into sixteen i.e. there appears an orbit of period $2^4 = 16$, and so on. At the end of the period-doubling cascade, i.e. at $r \approx 3.569946\ldots$ , there is the onset of chaos i.e. there appears an orbit of infinite period (solution does not contain a periodic orbit) but there sometimes appear islands of stability i.e. the period-doubling windows.

The bifurcation diagram for the Logistic Map is a function $x = f(r)$.

The first Feigenbaum constant results from a numerical work. It is given by the limit

$$\delta = lim_{n\to\infty}\, (r_{n-1} - r_{n-2}) / (r_n - r_{n-1}) = 4.669201609\ldots, \tag{2}$$

where $r_n$ are discrete values of $r$ at the $n$th period-doubling. We can see that the successive bifurcations are separated by a distance that asymptotically decreases geometrically by the factor $\delta$.

In the Chaos Theory (ChT) there is defined an operator that performs the iteration and rescaling. Such operator has a fixed point solution for a particular value of $\alpha$ (it is the second Feigenbaum constant)

$$\alpha \approx 2.50281. \tag{3}$$

Here, applying the Scale-Symmetric Theory (SST) [6], we show how particle physics via the Chaos Theory leads to the cosmological dark-matter structures and mental solitons. Moreover, the interactions of the cosmological dark-matter structures with baryonic matter via weak interactions of leptons, lead to the untypical motions of stars in galaxies and to structure of the active galactic nuclei (AGN) composed of a torus and a central-condensate/modified-black-hole. Modified black hole (MBH) has not a central singularity but there is an orbit with the spin speed equal to the speed of light in "vacuum" $c$.

Emphasize that all not calculated here but used theoretical results and used arguments without sufficient explanations follow from paper [6] (Particle Physics) and [7] (Cosmology). Calculated masses of particles in paper [6] that we will use in this paper are as follows: $m_{Kaon(+,-)}$ = 493.733693 MeV, $m_{Kaon(o)}$ = 497.759913 MeV, $m_{Muon,free}$ = 105.656314 MeV, $m_{Muon,bound}$ = 105.82889 MeV, $m_{Pion(+,-)}$ = 139.57041 MeV, $m_{Neutron,free}$ = 939.5648 MeV, $m_{Neutron,bound}$ = 939.5378 MeV, $m_{Proton}$ = 938.2725 MeV, $m_{Electron}$ = 0.510998906 MeV. Equatorial radius of the core of baryons and radius of the first orbit is $R_0 = A \approx 0.7$ fm, of the second orbit is $R_1 = A + B \approx 1.2$ fm, of the third orbit is $R_2 = A + 2B \approx 1.7$ fm, and of the last one is $R_4 = A + 4B \approx 2.7$ fm.

The General Relativity leads to the Higgs field composed of non-gravitating tachyons [6]. The succeeding phase transitions of such Higgs field lead to different scales. There appear the superluminal entanglons responsible for the superluminal quantum entanglement, the luminal Einstein spacetime composed of the neutrino-antineutrino pairs, cores of baryons and the cosmological structures (protoworlds) [6]. Some phenomena associated with the core of baryons lead to the atom-like structure of baryons. The core consists of a condensate with a mass of $Y$ = 424.1245 MeV ≈ 4·106 MeV, of a torus with a mass of $X$ = 318.3 MeV ≈ 3·106 MeV, and of the $S$ state with the mean mass about $W$ = 212.2 MeV ≈ 2·106 MeV. Notice that following expression: $[(X + Y) / S] / (X / Y) \approx 14 / 3 = 4.6666(6)$ gives theoretical result close to the first Feigenbaum constant. But we will show that the origin of this constant is associated directly with masses of charged kaon and muon.

## 2. The logistic map for proton, physical origin of the period-doubling cascade in proton and the Feigenbaum constants, and the leaking dark-matter structures

### 2.1 The logistic map for proton

So what is the logistic map of a proton? The answer is very simple: it is the spectrum of a black body – it is a one-hump/one-maximum inside the nuclear strong field of proton. Since the size of the strong field is finite so the black-body spectrum is cut off on the edge of this field. There are produced the virtual concentric loops composed of the entangled luminal non-rotating-spin neutrino-antineutrino pairs which are entangled with the proton – they are the dark-matter structures. They appear in the Einstein spacetime but because their absolute mass density is invariant so the linear mass density of the virtual loops is constant. It causes that their absolute mass is directly proportional to their radius i.e. to the reduced Compton length $\lambda\!\!\!^{-}_C$. Since the neutrino-antineutrino pairs are luminal so the spin speed of all loops is equal to the speed of light in "vacuum" $c$. We can see that the periods of spinning of the loops are directly proportional to their radii so to their absolute masses also. Such loops can expand but due to the invariance of total velocity of their components, the radial velocity increases when the spin velocity decreases. Since $m = const.$ so from constancy of angular momentum: $m\, v_{Spin}\, r = const.$ is $v_{Spin} \sim 1 / r$.

**Define the argument $x$ of a logistic map for proton as the ratio of absolute mass of a loop to maximum absolute mass of virtual loops (it is for the edge of the nuclear strong field). Then, the argument changes from 0 for the centre of proton to 1 for the edge of the nuclear strong field.**

On the other hand, there is the Wien's law that ties temperature of a black body with length of wave for the maximum in the black body spectrum – the product is constant:

$\lambda\!\!\!^{-}_{C,max\text{-}intensity} \cdot T_{\lambda\!\!\!^{-}} = const.$.

We can see that temperature is inversely proportional to the reduced Compton length for the maximum. Since absolute mass of a virtual loop is directly proportional to the reduced Compton length so temperature is inversely proportional to the absolute mass of a loop corresponding to the maximum for the logistic map. We can see that with increasing temperature of nuclear matter, the maximum of the logistic map is closer and closer to the centre of a proton and the corresponding absolute mass for the maximum is lower.

The above remarks suggest that we can manipulate the steepness of the hump/maximum in the logistic map changing the relativistic mass of the proton. We know from experimental data that with increasing energy density of nuclear matter, the running coupling for the nuclear strong interactions decreases [6]. It means that mass of the virtual pions responsible for the nuclear strong interactions decreases when temperature of nuclear matter increases – it results from the law of conservation of spins of nucleons [6]. Experimental data show that with increasing energy of collision of nucleons there is produced more and more the pions and kaons and less and less other particles. It is consistent with the theory of baryons presented in paper [6] – at high energy the cores of baryons are packed to maximum so there dominate the processes associated with the core. The pions are produced on the circular axis inside the core whereas the kaons are produced on the equator of it. Absolute rest mass of the virtual kaons does not change with increasing energy of collisions whereas absolute mass of the virtual pions decreases [6].

**It suggests that we can manipulate the steepness of the maximum of the logistic mass defining the parameter $r$ as the ratio of the absolute rest mass of virtual kaon to the absolute running mass of virtual pion: $r = m_{Kaon(+,-)} / m_{Pion(+,-)}$ – with increasing temperature the $r$ increases.**

In the definition we use the charged particles because such virtual particles can produce the dark-matter loops entangled with virtual charged leptons that can interact with charged baryonic matter via the long-distance electromagnetic interactions.

### 2.2 The Titius-Bode law for the nuclear strong interactions as a result of creation of attractors in the logistic map for proton

The lower limit for the parameter $r$ of a period-doubling cascade in proton is

$$r_L = m_{Kaon(+,-)} / m_{Pion(+,-)} \approx 3.537524 . \tag{4}$$

Applying formula (4) we can calculate the running absolute mass for the onset of chaos and next the relativistic speed of protons for the beginning of chaos (the formula is $M_{Running,Pion} = M_{Rest,Pion} \, (1 - v^2 / c^2)^{1/2}$ [6]). We obtain $v \approx 0.1344668c$. It leads to the relativistic mass of proton equal to $946.87$ MeV i.e. there is the increase in mass about $8.60$ MeV.

The parameter ranges which are defined below formula (1), lead to conclusion that the lower limit produces the dark-matter loop/orbit of period $4$ i.e. there are the $4$ attractors.

For such value of the parameter $r$, the values of the $4$ attractors (we use formula (1)) are as follows

$$X_{A1} \approx 0.882877 , \tag{5a}$$
$$X_{A2} \approx 0.365799 , \tag{5b}$$
$$X_{A3} \approx 0.820670 , \tag{5c}$$
$$X_{A4} \approx 0.520620 . \tag{5d}$$

On the other hand, SST leads to following resonance masses of charged $S$ bosons/loops produced inside baryons (the quantum azimuthal number is equal to zero) that overlap with the Titius-Bode orbits for the nuclear strong interactions in baryons ([6] – see Table 2; virtual loops with such absolute masses are the dark-matter structures)

$$M_{S(+,-),d=0} \approx 727.44 \text{ MeV} , \tag{6a}$$
$$M_{S(+,-),d=1} \approx 423.04 \text{ MeV} , \tag{6b}$$
$$M_{S(+,-),d=2} \approx 298.24 \text{ MeV} , \tag{6c}$$
$$M_{S(+,-),d=4} \approx 187.57 \text{ MeV} . \tag{6d}$$

Notice that there are satisfied following relations

$$X_{A1} / X_{A2} \approx 2.41 \approx M_{S(+,-),d=0} / M_{S(+,-),d=2} \approx 2.44 \approx R_2 / R_0 \approx 2.44 , \tag{7a}$$
$$X_{A1} / X_{A4} \approx 1.70 \approx M_{S(+,-),d=0} / M_{S(+,-),d=1} \approx 1.72 \approx R_1 / R_0 \approx 1.72 . \tag{7b}$$

There is no mass in baryons associated with the attractor $X_{A3} \approx 0.820670$. But we can rewrite formula (1) as follows

$$x_{n+1}^* = \; x_{n+1} / r = \; x_n \, (1 - x_n), \tag{8}$$

i.e. there instead the attractor $X_{A3}$ can appear the attractor $X_{A3}^*$ (notice that the third attractor we obtain applying in formula (1) the second attractor)

$$X_{A3}^* = X_{A2} \, (1 - X_{A2}) \approx 0.231990 . \tag{9}$$

Now we can see that there is satisfied following relation

$$X_{A1} / X_{A3}^* \approx 3.81 \approx M_{S(+,-),d=0} / M_{S(+,-),d=4} \approx 3.88 \approx R_4 / R_0 \approx 3.88 . \tag{10}$$

The values in formulae (6) are the central values and because of the Uncertainty Principle, there appear the full widths of the masses of the components of baryons – especially it concerns the resonances so mainly the $M_{S(+,-),d}$ masses. Most important are the symmetrical decays of bosons that lead to the precise masses of nucleons [6].

We can see that the four attractors lead to the Titius-Bode law for the dark-matter orbits/attractors in baryons

$$R_d = A + dB , \tag{11}$$

where $A \approx 0.7$ fm, $B \approx 0.5$ fm, whereas $d = 0, 1, 2, 4$. We derived this formula in a different way as well [6].

Emphasize once more that the logistic map for proton associated with the black-body spectrum leads to the Titius-Bode law for the nuclear strong interactions.

The dark-matter structures interact with baryonic matter via the weak interactions of leptons but the baryonic matter is transparent for the dark-matter structures.

The spin speeds of the components of the dark-matter loops are equal to the $c$ so the oscillations defined by the attractors are between the Titius-Bode orbits.

### 2.3 Physical origin of the period-doubling cascade for proton and Feigenbaum constants

With $r$ between about $3.44949\ldots$ and $3.54409\ldots$, the baryons/protons approach permanent oscillations among four values/orbits.

From formula (4) follows that due to the running coupling for the nuclear strong interactions, the parameter $r$ increases with increasing temperature of nuclear matter so there appear the orbits of periods $8$, $16$, $32$, and so on, and for value $r = 3.569946\ldots$ there is the onset of chaos. There appears the first Feigenbaum constant $\delta$. But in baryons/protons we can define this constant in a different way also (notice that in the main channel, the charged pions decay to muons so their mass is a mass limit)

$$\delta = m_{Kaon(+,-)} / ((m_{Muon,free} + m_{Muon,bound}) / 2) = 4.6692033\ . \qquad (12)$$

It suggests that the first Feigenbaum constant is associated with the main channel of decay of charged pions. The PDG data, [8], give $4.6723889$ and this result is much worse than obtained within SST – it follows from the fact that within SST we can calculate precise mass of muon in a bound state inside baryons.

The second Feigenbaum constant is close to following ratio

$$\alpha = ((m_{Neutron,free} + m_{Neutron,bound}) / 2 - m_{Proton}) / m_{Electron} = 2.502424\ . \qquad (13)$$

It suggests that the second Feigenbaum constant is associated with the beta decay. The PDG data, [8], give $2.530990$ and this result is much worse than obtained within SST – it follows from the fact that within SST we can calculate precise mass of neutron in a bound state.

### 2.4 The leaking dark-matter structures

SST shows that photons and gluons are the rotational energies of the neutrino-antineutrino pairs. The difference between the photons and gluons follows from the fact that their carriers have internal helicity so they behave in a different way in fields that have not internal helicity (gravitational and electromagnetic fields) and in field having internal helicity as the nuclear strong fields. We can see that on boundary of the nuclear strong fields there is the gluon-photon "transformation". It means that there leak the dark-matter structures/loops produced by protons. Many physical systems, due to the long-distance entanglement and confinement that cause that the luminal Einstein spacetime (composed of the neutrino-antineutrino pairs) behave in a non-linear way. The non-linear part of the Einstein spacetime, due to its weak interactions with baryonic matter via leptons, causes that behaviour of many physical systems can by described by using the Chaos Theory.

### 2.5. The Titius-Bode law and bifurcation

The chaos game method [9] leads to the Sierpinski triangle associated with the Pascal triangle [10]. The sum of the numbers in the succeeding lines of the Pascal triangle are equal to $d = 1, 2, 4, 8, 16, 32, 64, 128, 256,$ and are characteristic for the Titius-Bode law

$$R_d = A + dB, \qquad (14)$$

where $A/B \approx 1.39$ [6]. We showed that the Titius-Bode law is associated with fractal geometry i.e. travelling half-distances, distribution of sources of interactions, and the creation

of consecutively smaller self-similar physical objects/loops because of the symmetrical decays of virtual bosons (bifurcation) [6].

**2.6 Prime numbers and the Titius-Bode law and solar system**

To obtain the Titius-Bode law we need succeeding symmetrical decays of an object. For example, for the nuclear strong interactions proton and neutron looks the same so there is a probability not equal to zero that in appropriately high temperature an atomic nucleus composed of $256$ nucleons will decay symmetrically $8$ times:

$256 \rightarrow 128 \rightarrow 64 \rightarrow 32 \rightarrow 16 \rightarrow 8 \rightarrow 4 \rightarrow 2 \rightarrow 1$.

Ranges of particles are inversely proportional to their masses. Assume that an atomic nucleus containing $256$ nucleons appears on equator of a sphere and has range $B^*$. It means that in distance $B^*$ from the equator it decays into $2$ nuclei each containing $128$ nucleons. But there is the quantum entanglement between the products of decay so when one component stops then the second must stop also. First part is moving towards the equator and stops on it so the second part covers the distance $B^*$ only, i.e. it decays in distance $2B^*$ from the equator, and so on. It leads to following series representing the distances between the places of symmetrical decays (notice that the returning nuclei can decay on the equator as well)

$1B^*, 1B^*, 2B^*, 4B^*, 8B^*, 16B^*, 32B^*, 64B^*, 128B^*,$

i.e. each element in the series is the sum of all lower elements.

The Titius-Bode law should be somehow associated with the theory of prime numbers because there is very high probability that there is only one series of prime numbers that contains the same number of elements. Consider following series of prime numbers (we can call this series the mathematical Titius-Bode law)

$$N_{Prime} = 5 + 6\,d\,, \tag{15}$$

where $d = 0, 1, 2, 4, 8, 16, 32, 64,$ and $128$.

The series representing the distances between successive prime numbers for $B^* = 6$ is the same as for the symmetrically decaying nucleus containing $256$ nucleons.

But to obtain the physical Titius-Bode law, we need instead the prime number $5$ a number about $8.34$. Why contrary to mathematics, in physics the first number in series (15) is not important? And why in the solar system there appears an element close to $96B$ (it relates to Neptune)?

We showed that due to the dark-matter structures, the structure of proton enters the Einstein spacetime and next forces the other systems to be similar to proton (i.e. central condensate + torus (or core) + rings/orbits). For example, quasars consist of central condensate (a black hole) and torus, planetary systems consist of a core (a star) and orbits, atoms consist of a core (a nucleus) and shells. The equatorial radius of the proton, $A$, is fixed by the initial conditions concerning the two components of spacetime (i.e. the superluminal Higgs field and the luminal Einstein spacetime [6]), whereas the shells outside the core are fixed by both, the symmetrical decays of virtual bosons and the non-linear effects described within the Chaos Theory. So, if some other phenomena do not disturb the systems, the proton and planetary systems should be self-similar.

In the protons there can take place following phenomenon. In the $d = 1$ state (its radius is $A + B$) there are created the virtual bosons with a mass of $M_{S(+,-),d=1} \approx 423.04$ MeV. It means that in the $d = 1$ state can appear the virtual weak mass of such boson: $M_{Weak} =$

$\alpha_{w(proton)}\, M_{S(+,-),d=1}$, where $\alpha_{w(proton)} = 0.0187229$ [6]. Next, the structure of proton shows that this mass creates the dark-matter loops with radius $A + B + 94.73B = A + 95.73B \approx A + 96B$ (they are outside the nuclear strong field of a proton). It corresponds with the element concerning Neptune i.e. about $96B$.

Emphasize that we do not need the symmetrical decays of atomic nuclei to create the solar system – just there are the quantized radii of the dark-matter loops (due to the period-doubling cascade). We can treat the symmetrical decays of nucleus containing $256$ nucleons as an illustrative example.

**3. Mental solitons**

It is very important to unify the particle physics with the mental world via a single field. Consider arrangements of spins of the neutrino-antineutrino pairs in the Einstein spacetime.

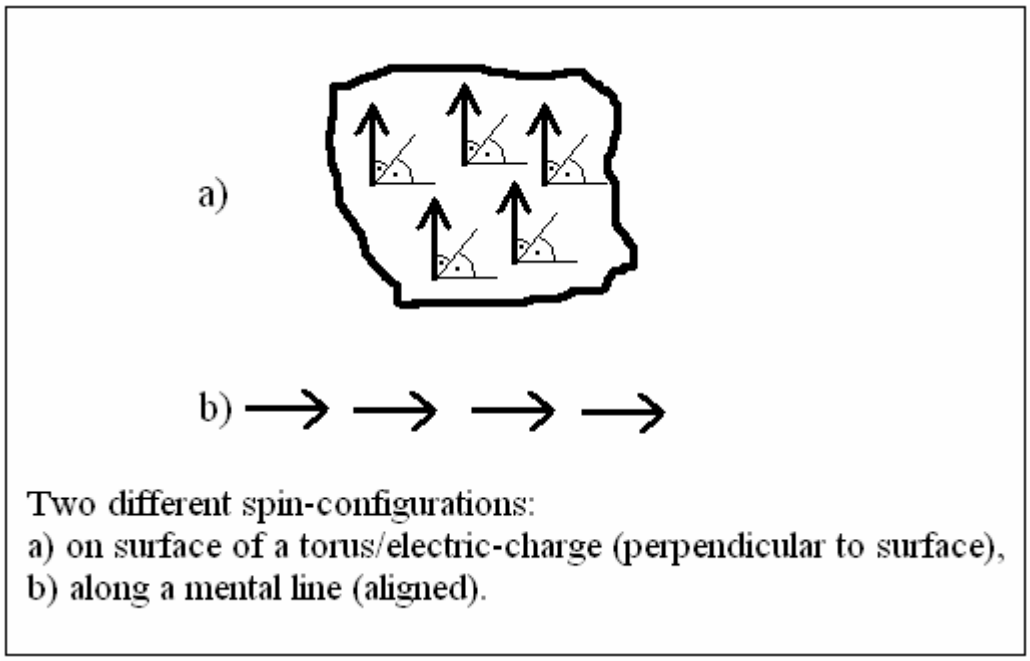
There are two different spin-configurations of entangled non-rotating-spin neutrino-antineutrino pairs. One configuration leads to the tori/electric-charges whereas the second one leads to the mental lines that can be closed (Fig.).

A mental soliton consists of crossing sets composed of concentric circles/loops built of the non-rotating-spin neutrino-antineutrino pairs with aligned spins. Such tangled solitons are the 3-dimensional dark-matter structures. They are the flexible but stable structures and they can penetrate through baryonic matter.

Tangled circular electric currents, so those inside atoms and brains as well, create the mental solitons. Our minds consist of such solitons. Due to the current decays and circuit breakers (for example, neurons can do this), entangled smaller and smaller self-similar mental solitons are produced.

There leaks the internal structure of protons so to the mental solitons we can apply the Chaos Theory.

We can see that there is the new element in the Chaos Theory that leads to the mental solitons and their interactions so partially the ChT is a paradigm.




Two different spin-configurations:
a) on surface of a torus/electric-charge (perpendicular to surface),
b) along a mental line (aligned).

Due to the long-distance quantum entanglement, we cannot fully understand Nature neglecting the dark-matter structures.

**4. Motions of stars in galaxies (the dark-matter mechanism)**

Due to the weak interactions of the virtual cosmological dark-matter loops (which are produced in the Einstein spacetime) with baryonic matter (via leptons), there appears the advection i.e. the stars acquire their spin speeds around the centres of galaxies.

There dominates the mass of the central bulge so from formula

$$v^2 = G\, m / r \tag{16}$$

follows that spin speed $v$ is directly proportional to square root from luminal mass of a galaxy: $v \sim (m_{galaxy})^{1/2}$.

The mass of a galaxy responsible for the weak interactions via the leptons is $\alpha\ m_{galaxy}$, where $\alpha$ is the coupling constant. This coupling constant is calculated within SST [6]

$$\alpha_{w(electron\text{-}muon)} = 9.511082 \cdot 10^{-7}. \tag{17}$$

This value is for two interacting particles but there is obligatory the four-particle/object symmetry, [6], so coupling constant for a quadrupole is $2\alpha_{w(electron\text{-}muon)}$.

Now we can write the formula for the speeds of orbiting the centres of galaxies by stars which follow from the dark-matter-loops---baryonic-matter advection

$$v_{spin\text{-}speed,advection} = c\,(2\alpha_{w(electron\text{-}muon)}\, m_{galaxy} / m_o)^{1/2} = const.. \tag{18}$$

Initial mass of typical massive spiral galaxy was $m_{o,MBH,S} = 2M_{Protogalaxy} \approx 2.131 \cdot 10^{11}\ M_{Sun}$ [7]. Due to the initial Double Cosmic Loop, [7], the upper limit for initial mass of such galaxy is two times greater so the upper limit for barred one is $m_{o,MBH,mean,barred} \approx 8.5 \cdot 10^{11}\ M_{Sun}$. 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).

The speed of light in "vacuum" $c$ in formula (18) says that stars interact with the dark-matter-structures/cosmological-loops produced due to the non-linear effects in the baryonic matter in the centres of galaxies, whereas $\alpha_{w(electron\text{-}muon)}$ says that the interactions are via the weak interactions of electrically charged leptons.

Calculate the speeds of stars on their orbits in 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 [11]), in the Milky Way at the assumption that its visible mass is $m_{MW} = 0.8 \cdot m_{M31} \approx 2.9 \cdot 10^{11}\ M_{Sun}$ and in 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 (18) we obtain:

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

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

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

$v_{spin\text{-}speed,advection,M33} = 142$ km/s.

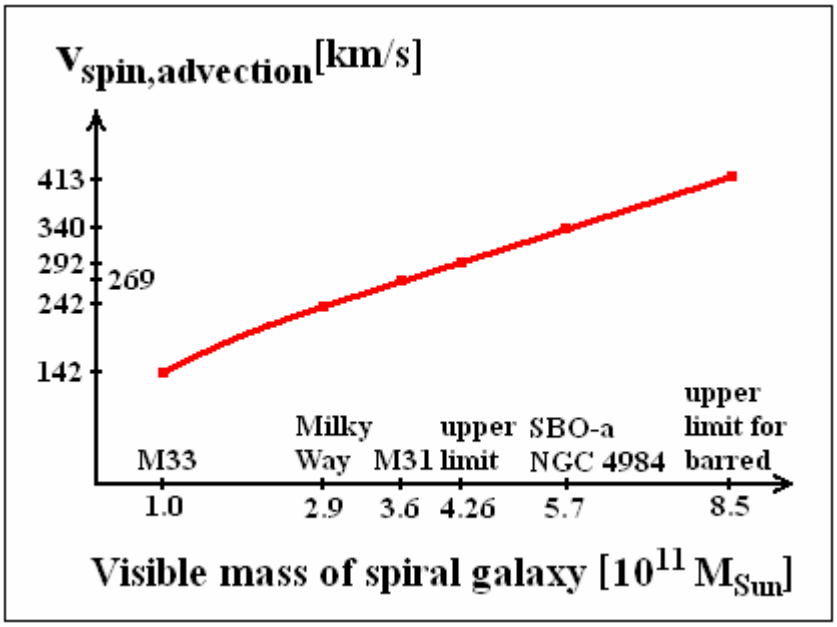
The obtained results are consistent with observational facts and are collected in Fig.

Notice that from formulae (16) and (18) follows that for barred spiral galaxies is

$$v_{max\text{-}spin\text{-}speed,advection,barred} = 2^{1/2}\, v_{max\text{-}spin\text{-}speed,advection}. \tag{19}$$

Formula (19) leads to conclusion that maximum speed on an orbit in barred spiral galaxies is 413 km/s. For barred spiral galaxy SBO-a NGC 4984 is $v_{spin\text{-}speed,advection,barred} \approx 340$ 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 ordered motions decrease local dynamic pressure in the Einstein 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 too 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.

**5. Summary**

Here, applying the Scale-Symmetric Theory (SST), we show how particle physics via the Chaos Theory leads to the cosmological dark-matter structures and mental solitons. Moreover, the interactions of the cosmological dark-matter structures with baryonic matter via weak interactions of leptons, lead to the untypical motions of stars in galaxies and to other cosmological structures such as AGN composed of a torus and a central-condensate/modified-black-hole.

Most important in the Chaos Theory (ChT) is to understand physical meaning of a logistic map for the baryons – it concerns the black-body spectrum and the ratio of the masses of charged kaon and pion. Such logistic map leads to the first Feigenbaum constant related to the period-doubling bifurcations that in a limit lead to the onset of chaos. In the period-doubling bifurcations for proton there appear the orbits of period-4 and higher periods. We showed that the orbits of period-4 follow from the structure of baryons and that they lead to the Titius-Bode law for the nuclear strong interactions. Emphasize that the logistic map for proton associated with the black-body spectrum leads to the Titius-Bode law for the nuclear strong interactions.

Calculated here on base of the structure of proton the first Feigenbaum constant is 4.6692033 and it is close to the mathematical value 4.6692016…

The non-linear part of the Einstein spacetime that follows from the quantum entanglement and confinement of the neutrino-antineutrino pairs, due to its weak interactions with baryonic matter via leptons, causes that behaviour of many physical systems can by described by using the Chaos Theory.

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