The Structure of Proton and Spin Crisis

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Abstract: Here, within the Scale-Symmetric Physics/Theory (S-ST), is presented some recapitulation concerning structure of proton. It shows that distribution of gluons described within the Quantum Chromodynamics is incorrect - there appears the spin crisis. The S-ST shows that there appear three super-dense fields composed of the carriers of gluons i.e. of the luminal Einstein-spacetime components. The three super-dense gluon fields follow from the short-distance quantum entanglement and/or confinement of the Einstein-spacetime components and they are as follows: the torus/strong-charge (its mass density is about 37 powers of ten kilograms per cubic meter; external radius is about 0.7 fm), central condensate (its mass density is about 3 times greater than 23 powers of ten kilograms per cubic meter; radius is about 0.009 fm) and relativistic pion on the S orbit (radius of the orbit is about 1.2 fm). Range of the strong interactions is about 2.9 fm. Within such model we calculated the rigorous mass, spin and two radii (the electron radius and muon radius) of proton. The torus/strong-charge is spinning and its spin is half-integral. We can compare the densities of the super-dense gluon fields with the mean mass density of proton on assumption that its radius is the range of the strong interactions: about 1.6 times greater than 16 powers of ten kilograms per cubic meter. Barbara Jacak, a professor of physics at the University of California, Berkeley, claims that the much faster than expected formation of baryonic-plasma droplets and the spin crisis follow from existence of a super-dense gluon field instead discrete gluons - it is consistent with S-ST.

Here [1], we can find a description of scientific program of the Relativistic Heavy Ion Collider (RHIC). Barbara Jacak, a professor of physics at the University of California, Berkeley, claims that the much faster than expected formation of baryonic-plasma droplets and the spin crisis concerning proton (within the QCD we still cannot show the origin of the half-integral spin of proton) follow from existence of a super-dense gluon field instead discrete gluons - it is consistent with S-ST presented here [2].

The Scale-Symmetric Theory (S-ST), [2], starts from the succeeding phase transitions of the Higgs field. The third phase transition leads to the internal structure of the core of baryons (the torus/strong-charge and the central condensate). Due to the symmetrical decays of bosons, on equator of the torus and outside it there appear the orbits/shells. In the d = 1 state of proton (it is the S state) there is relativistic pion. Proton is the black hole in respect of the strong interactions. We can see that in a proton, at low energy, we can distinguish three super-dense gluon fields i.e. the condensate, torus and the relativistic pion on the d = 1 orbit. The torus is spinning and its spin is half-integral.

The gluons and photons are the rotational energies of the Einstein-spacetime components i.e. the gluons and photons are the rotational energies of the neutrino-antineutrino pairs – they are the Feynman partons. At high energy of colliding nucleons, there appear the parton showers. Outside the strong fields the gluons behave as photons – it is due to the fact that the strong fields have internal helicity (the color) whereas the electromagnetic fields are colorless.

When distance between the Einstein-spacetime components is a few times greater than the Planck length, there appears the shortest-distance entanglement which leads to the super-dense gluon fields (more precisely: leads to the super-dense fields composed of the carriers of gluons) – such distances between the carriers of gluons are on surface of the torus.

When distance between the Einstein-spacetime components is smaller than about $3.5 \cdot 10^{-32}$ m, there appears the confinement which follows from the Mexican-hat mechanism concerning the Einstein-spacetime components. The confinement leads to super-dense gluon field also and they as well are composed of the carriers of gluons – in such a way behaves the carriers of gluons in the central condensate.

The mass density of the surface of the torus is about 10^{37} kg/m^3 (external radius of the torus is about 0.7 fm) whereas mass density of the central condensate is about $3 \cdot 10^{23}$ kg/m^3 (radius is about 0.0087 fm).

Radius of the d = 1 orbit (the S state) of the relativistic pion is about 1.2 fm.

Range of the strong interactions is about 2.9 fm.

Within such model we calculated the rigorous mass and spin of proton [2], and two radii (the electron radius and muon radius) of proton [3].

We can compare the densities of the super-dense gluon fields with the mean mass density of proton on assumption that its radius is the range of the strong interactions (about 2.9 fm): the mean proton mass density is about $1.6 \cdot 10^{16}$ kg/m^3. This density is much lower than the super-dense gluon fields.

At high energy collisions of nucleons the external orbits/shells are destroyed whereas the cores of nucleons are packed to maximum – it is the baryonic plasma. Its minimum mean mass density is about $1.8 \cdot 10^{18}$ kg/m^3. But inside the cores of nucleons the baryonic plasma consists of can be produced particles so resultant mean density can be higher.

References

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[2] Sylwester Kornowski (6 March 2015). “The Scale-Symmetric Physics” http://vixra.org/abs/1203.0021 .

[3] Sylwester Kornowski (29 January 2013). “The Root-Mean-Square Charge Radius of Proton” http://vixra.org/abs/1301.0174 .