Magnetic field contribution to black-hole-hedgehog's solution in GraviWeak unification

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1. We investigated the topological structure of the universal vacua.

   Different phase transitions, which were resulted during the expansion of the early Universe after the Planck era, produced the formation of the various kind of topological defects in vacua of the Universe.
2. The aim of this investigation is the consideration of the hedgehog configurations as defects in the false vacuum.
3. We have obtained a solution for a black-hole in the region which contains a global monopole in the framework of the $f(R)$ gravity, where $f(R)$ is a function of the Ricci scalar R.

   Here we have used the results of the Gravi-Weak unification (GWU) model.
4. In this GWU approach, we obtained a “hedgehog” solution (in Alexander Polyakov’s terminology).

   We also showed that this is a black-hole solution, corresponding to a global monopole that has been “swallowed” by a black-hole.

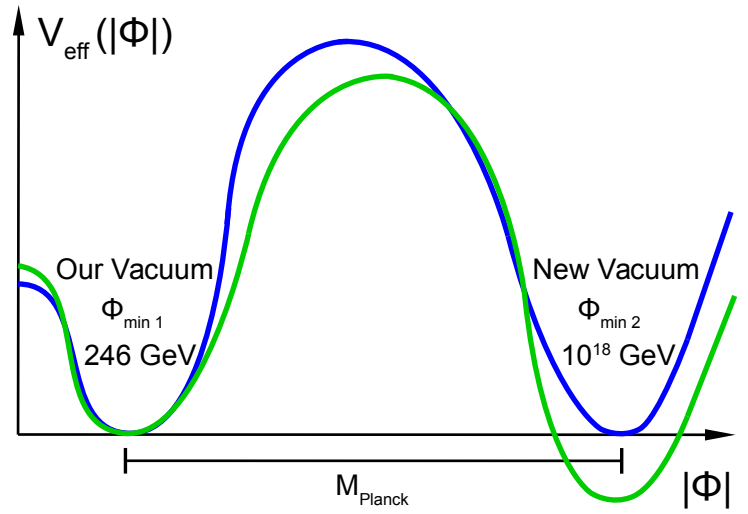
We were based on the discovery that a cosmological constant of our Universe is extremely small, almost zero, and assumed a new law of Nature which was named as a Multiple Point Principle (MPP).

The MPP postulates:

There are two vacua in the SM with the same energy density, or cosmological constant, and both cosmological constants are zero, or approximately zero.

We considered the existence of the following two degenerate vacua in the SM:

1. the first Electroweak vacuum at $v_1 = 246$ GeV, which is a "true" vacuum, and
2. the second "false" vacuum at the Planck scale with VEV $v_2 \sim 10^{19}$ GeV.



Minima of the effective Higgs potential in the pure Standard Model, which correspond to the first Electroweak “true vacuum”, and to the second Planck scale “false vacuum”.

- Here we have taken into account the contribution of the magnetic field of hedgehogs.
- The bubble, which we refer to as “the false vacuum”, is a de Sitter space with its constant expansion rate H_F.

  The initial radius of this bubble is close to the de Sitter horizon, which corresponds to the Universe radius.

  The space-time inside the bubble, which we refer to as “the true vacuum”, has the geometry of an open FLRW universe.
- By solving the gravitational field equations we estimated the black-hole-hedgehog’s mass, radius δ and horizon radius r_h.

  They are:

$$M_{BH} \approx 3.65 \times 10^{18} \text{ GeV},$$
$$\delta \approx 6 \cdot 10^{-21} \text{ GeV}^{-1}$$
$$\text{and } r_h \approx 1.14\delta.$$

- We estimated all parameters of the Gravi-Weak unification model, which gave the prediction of the Planck scale false vacuum VEV equal to $v = 2\sqrt{2}M_{Pl}^{red} \approx 6.28 \times 10^{18}$ GeV.
- We have shown, that the Planck scale Universe vacuum is described by a non-differentiable space-time:

  by a foam of black-holes, or by lattice-like structure, where sites are black-holes with the “hedgehog” monopoles inside them.

  This manifold is described by a non-commutative geometry, leading to a tiny value of cosmological constant $\lambda \approx 0$.

- Taking into account that the phase transition from the “false vacuum” to the “true vacuum” is a consequence of the electroweak spontaneous breakdown of symmetry $SU(2)_L \times U(1)_Y \to U(1)_{el.mag}$, we considered topological defects of EW-vacuum:

  the Abrikosov-Nielsen-Olesen closed magnetic vortices (“ANO strings”) of the Abelian Higgs model and Sidharth’s Compton phase objects.

  We showed that the “true vacuum” (EW-vacuum) again is presented by the non-differentiable manifold with non-commutative geometry leading to an almost zero cosmological constant.

- We considered that due to the energy conservation law, the vacuum energy density before the phase transition is equal to the vacuum energy density after the phase transition:

  ρ_{vac}(at Planck scale) = ρ_{vac}(at EW scale).
- This result confirms the Multiple Point Principle:

  we have two degenerate vacua v_1 and v_2 with an almost zero vacuum energy density (cosmological constants).

The MPP is exact:

1. By this consideration we confirmed the vacuum stability of the EW-vacuum, in which we live.
2. The Planck scale vacuum cannot be negative because of the exact equality $V_{eff}(min_1) = V_{eff}(min_2)$.