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Electron as Kerr's super-rotating black hole

Alexander Burinskii

Theor. Phys. Laboratory, NSI, Russian Academy of Sciences

***Corresponding author**
Alexander Burinskii, Theor. Phys. Laboratory, NSI, Russian Academy of Sciences, B. Tulskaya 52 Moscow 115191 Russia

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Abstract

The known weakness of Gravity in particle physics is a delusion caused by underestimation of the role of spin. Spin of elementary particles is extremely high and exceeds mass on 20-22 orders (in unit's c = G = m = k = 1). The caused by spinning gravity frame-dragging distorts space much stronger than mass, that shifts the usual effective scale of gravitational interaction from Planck to Compton distances. We show that compatibility between gravity and quantum theory can be achieved without modifications of the Einstein equations, by using a model of super-bag a no perturbative particle like solution to supersymmetric system of the Landau-Ginzburg (Higgs) field equations. Super-bag generates a free from gravity Compton zone for quantum theory. Shape of the bag is defined unambiguously by spinning Kerr-Newman solution. For parameters of an electron (charge e, spin J, and mass m) super-bag forms a thin superconducting disk of Compton radius coupled with circular string along its perimeter. The supersymmetric LG (Higgs) model is naturally upgraded to Wess-Zumino super-QED model, forming a bridge to perturbative formalism of conventional QED.

Introduction

One of the main points of confrontation between Gravity and Quantum theory is the structure of elementary particles, which are considered in quantum theory as structure less, like an electron in Dirac theory, but must be represented as the extended field models in configuration space for compatibility with the stress-energy tensor of Einstein's equations.

A revolutionary step towards unification quantum with gravity was taken in superstring theory, which represented particles as extended strings. However, as one of its founders, John Schwartz, noted, "... Since 1974, superstring theory has ceased to be regarded as particle physics..." and" ... a realistic model of elementary particles still seems a distant dream ..." [1].

As an estimate of the characteristic size of the interaction of elementary particles with gravity, and the main scale of the superstring theory, the Planck length of 10^{-33}.cm was chosen, at which, according to a widely accepted opinion, gravity becomes strong and corresponds to the unification of gravity with quantum physics.

We argue that the weakness of the gravitational field and its insignificance for particle physics is a misconception based on underestimating the role of spin. The spin of elementary particles is 20-22 orders of magnitude higher than their masses (in dimensionless unit's G = c = k = 1) and has a strong effect on the metric, curving space, and even changing its topology, about 20 orders of magnitude higher than the Planck scale. The huge ratio between the spin and mass of elementary particles makes the influence of gravity extremely strong and even decisive in the problem of the interaction of gravity with quantum theory and in particle physics.

Gravitational black holes (BH) have been repeatedly considered as candidates for elementary particles since 1980, and since the 1990s, they have also attracted attention in the theory of superstrings.

Carter' s discovery (1968) that the Kerr-Newman (KN) black hole (BH) solution has gyromagnetic ratio of the Dirac electron leads to point of view that elementary particles can be considered as the Kerr- Newman over-rotating black hole (BH) solution. Over-rotating BH means spin J is very high, so that a = J/m >> m. Over-rotating BH is not BH because in this case the BH horizons disappear and there appears the hole of another type – wormhole, or the Einstein-Rosen bridge to another space.

Formation of BHs is related with gravitational effect of frame-dragging. The spin-bound giant rotation also drags the space, but in the direction of rotation, that leads to a new very important effect of the formation Wilson loop – a type of the circular closed string. The spin of elementary particles is so large that instead of the expected conflict of gravity with quantum theory at Planck distances, the space is deformed about 20 orders of magnitude stronger, already at the Compton distances, and quantum theory becomes practically inapplicable on such a curved space.

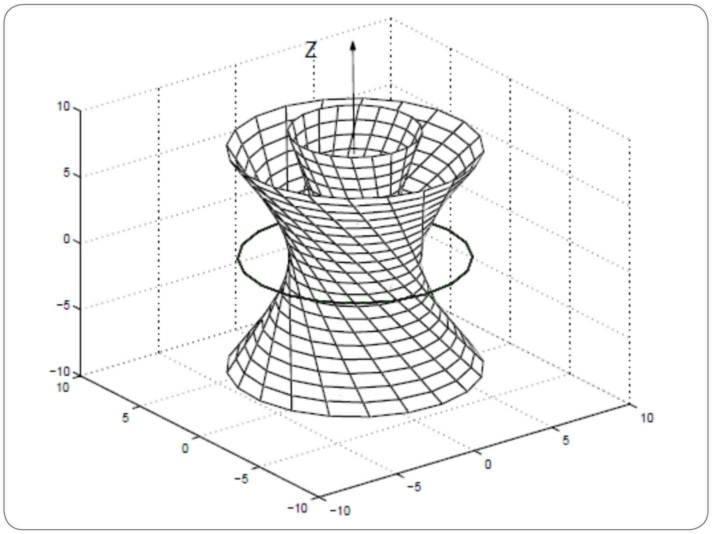

Figure 1: Kerr congruence and Kerr singular ring generated by null congruence k^{μ}.

The misconception on weakness of gravity has a huge negative impact on the development

of modern physics, since the Planck length l_p=1.610^{-33}cm is usually taken as the main
scale in a number of theories. In particular, this explains the main reason for the failure of modern superstring theory, related to the Planck string length, and the corresponding concept of extra dimensions. The transition to the Compton scale and interaction with the spinning gravity of KN BH solution opens up other possibilities and approaches to the still poorly developed versions of string theory without extra dimensions and compactification. In particular, to the soliton-like field models and to the bag models which are assumed to be flexible by design and acquire the string-like form and behavior when deformed [2-6]. Being field models, they allow forming the energy-momentum tensor necessary for interaction with gravity. Note that the gravitational strings associated with the Kerr metric were first discussed in our joint works with prof. D.D. Ivanenko, and after 1990, similar soliton models were also considered in the low-energy string theory by A. Sen mainly due to the attention to black holes [7-11]. The question of consistency with gravity is not usually discussed for soliton models, since it is usually assumed that the gravitational effects are very small compared to other forces.

The gigantic ratio between the spin and mass values for elementary particles breaks the generally accepted concept of the weakness of gravity and shows that the influence of gravity shifts up to Compton scale. Indeed, restoring the physical units, we obtain for the Kerr singular ring of an electron radius

$$|a| = \frac{J}{mc}, \tag{1}$$

which is the reduced 2π Compton wavelength. This differs drastically from for gravitational radius of the Schwarzschild BH

$$r_g = 2Gm \tag{2}$$

which is used typically for argument on the weakness of gravity. Thus, the gravitational field of an electron corresponding to the Kerr-Newman solution becomes singular and changes topology of space at the Compton distance.

We show that this conflict with quantum theory can be resolved without modifications of Einstein-Maxwell equations. However, a modification of the theory still occurs, and it is associated with the involvement of supersymmetry, i.e. with the additional inclusion of several chiral fields, forming the superconducting core of the Kerr spinning particle by the supersymmetric Higgs mechanism of spontaneous symmetry breaking [12-15]. In turn, supersymmetry has a similar property with respect to the gravitational field, which makes it possible to form a supersymmetric vacuum state that pushes the gravitational field out of the Compton zone of the particle. As a result, a super-bag is formed inside the particle, inside which supersymmetry forms a vacuum state free from the gravitational and electromagnetic fields. By analogy with the well-known MIT- and SLAC-bag models, [2, 3], formed as a non-perturbative solution of the Higgs model, the super-bag is formed on the basis of the supersymmetric Higgs model forming a flat internal space necessary for Compton core of quantum theory [12-15].

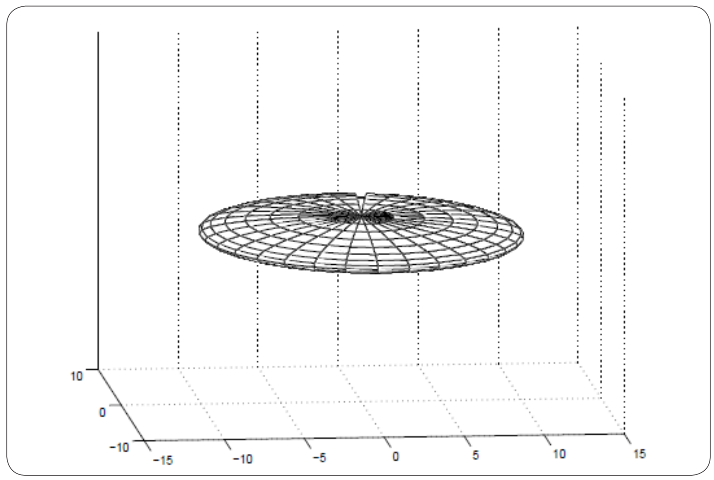

Figure 2: Disk-like shape of the Kerr-Newman bag model.

As a result of the conflict between Kerr gravity and quantum theory, two zones are formed: the outer classical (E) and the inner quantum (I), as well as the surface (S) separating these zones.

In the Kerr-Schild form [17] metric of Kerr-Newman solution has the form

$$g_{\mu\nu} = \eta_{\mu\nu} + 2Hk_{\mu}k_{\nu}, \tag{3}$$

where $\eta_{\mu\nu}$ is flat metric of the auxiliary Minkowski space, and H is the scalar function which for the KN solution has the form

$$H_{KN} = \frac{mr - e^2/2}{r^2+a^2\, COS^2\, \theta}. \tag{4}$$

Surface (S) is uniquely defined as the surface on which the Kerr-Newman is matched with the metric of flat space $\eta_{\mu\nu}$. One sees that it occurs at the surface where H(r) = 0, or by

$$r = r_e = e\hat{}2 / 2m \tag{5}$$

that corresponds to the value of a "classical" electron radius. However, r is here the Kerr radial coordinate, which marks indeed an oblate ellipsoidal surface. Therefore, the boundary (S) between the flat internal space and external Kerr-Newman gravity is defined unambiguously as a strongly oblate ellipsoidal surface – a very thin disk of about the Compton radius |a| and the thickness r_e, which is equal to classical electron radius. Note, that degree of oblateness $r_e/a = 1/137$ is the fine structure constant α.

Therefore, the Kerr-Newman spin parameter a leads to a strong deformation of the shape of the bag model. Such a strong deformation of the bag leads to the appearance of a relativistic string at the edge of the disk. This string is similar to the Nielsen-Olesen superconducting string [16], and it is formed as the Wilson loop embedded in the superconducting Higgs field.

Note, that this bag rotates relativistically, and the Compton size of the disk looks really much smaller to an observer at rest due to Lorentz contraction.

The low excitation of this string is associated with an electron model, while the other excitations can be related with other particles of the electroweak sector SM.

The principal null congruence of the Kerr geometry $k^\mu(x)$ is defined by Kerr theorem, which fixes geometric structure of the Dirac equation, keeping it consistent with Kerr- Newman gravity [17, 18].

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