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The Proton as A Kerr-Newman Black Hole

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Abstract: The general equation governing the mass, spin and angular momentum of a Kerr-Newman black hole applies equally well to a proton when the gravitational coupling constant predicted by a discrete fractal paradigm is used in the equation, along with the standard mass, spin and angular momentum of the proton.

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1. Introduction

A previous paper [1] demonstrated that the masses and radii of subatomic particles such as the proton and the alpha particle can be retrodicted to a first approximation using the basic physics of black holes, if the gravitational interactions *within* the subatomic particles are governed by a coupling constant that differs from the standard Newtonian constant by a factor of approximately 10^{38}. This somewhat radical revision of the fundamental scaling properties of gravitational interactions is derived from a discrete fractal paradigm for nature's global properties, which has been named the Self-Similar Cosmological Paradigm [2] (SSCP), or Discrete Scale Relativity [3]. According to this new paradigm, *discrete scale invariance* is a fundamental and universal symmetry principle that has not been adequately recognized in the past. The discrete self-similarity of nature's hierarchically organized systems is identified as the direct physical manifestation of this global discrete scale invariance. In the present paper a previously proposed discrete self-similarity between hadrons and Stellar Scale Kerr-Newman black holes [1] will be explored in somewhat more detail for the proton.

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2. Discrete Fractal Scaling for Gravitation

The SSCP argues that nature's unbounded hierarchical organization is divided into discrete cosmological Scales, of which we can currently observe the Atomic, Stellar and Galactic Scales. The discrete fractal scaling of the SSCP leads to the following expression for the coupling constants that characterize the gravitational interactions on differing cosmological Scales, as was discussed in a recent publication [3] on Discrete Scale Relativity:

$$G_\Psi = [\Lambda^{1-D}]^\Psi G, \tag{1}$$

where G is the conventional Newtonian gravitational coupling constant, which is appropriate for Stellar Scale calculations and is equal to 6.67 x 10^{-8} $cm^3/g\ sec^2$. The terms Λ ($\cong$ 5.2 x 10^{17}) and D ($\cong$ 3.174) are the dimensionless scaling constants that are fundamental to the SSCP. The term Ψ ($\equiv \ldots$-2, -1, 0, 1, 2...) is a quantized index that designates specific cosmological Scales, and $\Psi = 0$ is assigned to the Stellar Scale.

Using Eq. (1) we can determine that the gravitational coupling constants on neighboring cosmological Scales are related by the general equation:

$$G_{\Psi-1} = \Lambda^{2.174} G_\Psi. \tag{2}$$

In the specific case of Atomic Scale systems (Ψ = -1),

$$G_{-1} = \Lambda^{2.174} G_0 = 2.18x10^{31} cm^3/gsec^2. \tag{3}$$

Having determined the value of the SSCP's prediction for the appropriate gravitational coupling constant that applies *within* Atomic Scale systems, we can now show in a little more detail than was given before [1] that the mass/spin/angular momentum relationship of a Kerr-Newman black hole is in good agreement with an empirical mass/spin/angular momentum relationship for the proton.

3. Kerr-Newman Black Holes

Solutions of the Einstein field equations of General Relativity for spinning and charged black holes were achieved by Kerr [4] and Newman [5] several decades ago. An important and well known relationship [6] that applies to Kerr-Newman black holes is:

$$J = a_*[G_\Psi M^2/c]. \tag{4}$$

The symbol J designates the angular momentum of the object, a_* is referred to as the dimensionless spin parameter, G_Ψ is the appropriate gravitational coupling constant, M is the mass of the object, and c is the velocity of light. This equation, which was derived primarily for Stellar Scale black holes, also applies to the proton when the appropriate Atomic Scale values for J, G_Ψ and M are inserted.

4. The Proton as A Gravitational Black Hole

Conventional physics [7] has determined that the angular momentum of the proton (J_p) is:

$$J_p = [j(j+1)]^{1/2}h, \tag{5}$$

where j is the proton's dimensionless spin parameter, which equals ½, and h is Planck's constant divided by 2π. Given the standard equation for the Planck mass and the basic scaling rules of Discrete Scale Relativity, the SSCP asserts [8] that

$$h = G_{-1}M^2/c, \tag{6}$$

where M is the revised Planck mass based on G_{-1}, and is equal to 1.20 x 10^{-24} g. Therefore,

$$J_p = [1/2(1/2+1)]^{1/2}[G_{-1}M^2/c] = 0.866[G_{-1}M^2/c]. \tag{7}$$

If the proton is correctly modeled in terms of a Kerr-Newman black hole, then the following relationship should hold true in accordance with Eq. (4):

$$0.866[G_{-1}M^2/c] = a_*[G_{-1}m^2/c], \tag{8}$$

where m is the mass of the proton. Eq. (8) can be simplified since the G_{-1} and c terms cancel out. We can then insert values for M (= 1.20 x 10^{-24} g) and m (= 1.67 x 10^{-24} g) into the remaining equation and solve for a_*.

$$a_* = 0.866(M/m)^2 = 0.866(0.72)^2 = 0.45. \tag{9}$$

The fact that $a_* = 0.45 \approx$ ½ is encouraging since this agrees with the proton's empirically and theoretically determined dimensionless spin parameter at the 90% level.

A more accurate test can be achieved by the following method. Given G_{-1} as the correct gravitational coupling factor for geometrizing mass, charge and specific angular momentum, we may apply the full Kerr-Newman solution of the Einstein-Maxwell equations to the proton. Details of the geometrized methodology employed in the present paper can be found in chapter 33 of *Gravitation* by Misner, Thorne and Wheeler [9]. Calculations based on this method yield the following values for the radius and mass of the proton.

$$r = m + [m^2 - q^2 - a^2cos^2(\theta)]^{1/2} = 8.13 \times 10^{-14}cm \tag{10}$$

$$m = \{[m_{ir} + q^2/4m_{ir}]^2 + J^2/4(m_{ir})^2\}^{1/2} = 1.67x10^{-24}g \tag{11}$$

This demonstrates that the full Kerr-Newman solution of the Einstein-Maxwell equations accurately models the basic r, m, q and J properties of the proton when G_{-1} is adopted as the correct gravitational coupling factor within Atomic Scale systems. Small but currently unavoidable uncertainties involved in determining the fundamental self-similar scaling constants Λ and D of the SSCP prevent a more exact quantitative test at present, but such a test is in principle possible in the near future.

Conclusion

The main implication of the above results is that the equation

$$J_p = a_*[G_\Psi m^2/c] \tag{12}$$

models the proton's mass/spin/angular momentum relationship correctly when the appropriate value of G_Ψ is used in the calculations, in close analogy to Eq. (4). Within the context of the SSCP, the proton appears to be an Atomic Scale Kerr-Newman black hole.

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