

A Solution to Black Hole Information Paradox

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Abstract

This theoretical framework aims to unify black holes, dark matter, and dark energy into a single quantum gravity theory. By integrating quantum field theory such as electrodynamics, electroweak and general relativity, I address the black hole information paradox by proposing three fundamental postulates which lead to a deeper understanding of black hole's quantum gravity And mechanism where photon and neutral Z boson decay under extreme gravitational environment of black hole. Using the second order in Ricci Scalar curvature and its connection to the cosmological constant, I explore the quantization of the speed of light and area of event horizon. This article shows a startling relationship between black hole's gravitational potential, event horizon entropy, entanglement entropy and the role they play in preserving information across the event horizon.

Introduction

The pursuit of a unified theory of quantum gravity is central to resolving some of the most profound mysteries in theoretical physics, including the black hole information paradox. This paradox arises from the conflict between general relativity and quantum mechanics: while general relativity predicts that information entering a black hole is lost to the outside world, quantum mechanics maintains that information cannot be destroyed.

The framework proposed in this article builds on these concepts, suggesting that black holes, dark matter, and dark energy can be understood within a single unified theory of quantum gravity. In quantum electrodynamics, electrons and positrons interact by exchanging virtual photons, which are the quanta of the electromagnetic field. This exchange mediates the electromagnetic force between charged particles and also the Electroweak Theory, which unifies the electromagnetic force and the weak nuclear force, neutrinos interact via the weak nuclear force. This force is mediated by the exchange of virtual W and Z bosons. Specifically, electron neutrinos and anti-electron neutrinos interact

through the exchange of virtual Z bosons, which carry the neutral weak current. This article endeavors to unify quantum electrodynamics, electroweak and general relativity as a single theory of quantum gravity.

- *Suppose a spin zero particle at the event horizon of a black hole decays into electron-positron pairs. One outside the event horizon and the other inside the black hole. What will be the nature of the outgoing and the incoming particles?*

- *“It is the nature of the ground state of a quantum field of a black hole to be steady.”*

This postulate suggests that the quantum state of a quantum field of black hole is inherently steady which contradicts the traditional view of black hole emitting Hawking radiation and slowly losing mass. Evolution of quantum state of quantum system is described by unitary operation but if we consider S-matrix in the framework of quantum field theory we can not describe the transformation of black hole from its initial state to hawking radiation or even the reversal of Hawking radiation.

$$T^2(t)x = \int x e^x t^{-x} dx = \left(\frac{1}{1-t}\right)x \quad (1)$$

Equation (1) represents a force which increases with distance x . It also represents Laplace transformation over interval $[0, \infty]$, when $t = 0$ the second order of stress-energy scalar curvature is 1 then the force is equal to the distance between the particle outside and the other one inside black hole but at $t = 1$ it approaches infinity.

- *“Speed of light is quantized.”*

$$T^2 = 1 - \chi \quad (2)$$

Binomial approximation of stress-energy scalar curvature $T^2 = 1 + nx$ where $n = \frac{v}{c}$ is velocity and c is the speed of light. At $x = -1$, $T^n = 1 - n$ when the velocity is equal to one speed $T^1 = 0$ and at two speed of light it becomes $T^2 = 3$ for torus and $T^2 = -1$ for sphere. Where χ is Euler characteristics and it shows that stress-energy scalar curvature is related to discrete speed and specifically two speed of light.

$$R_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu} = 0 \quad (3)$$

$$R_{\mu\nu}R^{\mu\nu} = 1 - \frac{1}{4}R^2g_{\mu\nu}g^{\mu\nu} \quad (4)$$

$$R_{\mu\nu} - \frac{1}{2}g_{\mu\nu} = 1 \quad (5)$$

$$R_{\mu\nu}R^{\mu\nu} = \frac{1}{4}g_{\mu\nu}g^{\mu\nu} \quad (6)$$

$$R^2 = 3 \quad (7)$$

equation (3) is the vacuum solution of Einstein's Ricci curvature tensor, if we put together equation(4) and equation (6) we will arrive at equation(7) which is value of second order in ricci scalar curvature. We would observe that the value we got from second order in stress-energy scalar curvature for torus in equation(2) is the same as the value of second order in Ricci scalar curvature, So they are interchangeable.

$\langle \Lambda^2 \rangle$ represent the vacuum expected value of dark energy or cosmological constant and n represents the number of ground state, before the particle decays n=1 and after the particle decays n=2. Special orthogonal group SO(2) implies that $\det(A)^2 = \pm 1$ so,

$$\langle n|\det(A)^2|n \rangle = \langle \Lambda^2 \rangle = \langle AA^T \rangle \quad (8)$$

$$\langle \Lambda^2 \rangle = \pm \frac{2}{3}n^2 \text{Mev} \quad (9)$$

The vacuum expectation value of cosmological constant determines the energy scale. Before the spin zero particle decays the energy scale is 0.666Mev and after the it decays into electro-positron pairs the energy scale becomes 2.666Mev.

We know the empirical value of masses of electro-positron pairs, in the light of this we can determine the mass of the spin zero particle. I claim the mass of the spin zero particle is equal to the mass of electron.

The gravitational effect of second order in Ricci scalar curvature accelerates a particle at two speeds of light in the vacuum. So the rest mass of the spin zero particle increases up to twice of its original value, hence the particle decays into electro-positron pairs.

If this true for spin zero particle then we can do the same thing for photon. It is shown that speed is a inherent property of the curvature and that at two speed of light Ricci curvature is raised to power of two. The gravitational effect of curvature at the event Horizon accelerates photon at two speed of light, so its kinetic energy becomes twice its original value and it will become unstable. Hence it decays into two spin-half photons.

These also hold for electron neutrino and anti electron neutrino, if we put either of them inside the black hole and other outside the event horizon of the black hole then we can claim that gravity affects Z boson which carries neutral current.

With regards that Z boson has rest mass, I claim that the rest mass of a Z boson under the gravitational influence of Black hole will become twice its original value then decays into

positive charge spin half Z boson which carries positive current and its anti particle which carries negative current.

$$R^2 = \frac{\Lambda^2}{2n\pi\Phi} A^\mu A_\mu \quad (10)$$

$$R^2 = \frac{\Lambda^2}{2n\pi\Phi} J^\mu J_\mu \quad (11)$$

$$\frac{1}{\Phi} A^\mu A_\mu + \nabla^2 \Phi = \frac{1}{\Phi} A'^\mu A'_\mu \quad (12)$$

$$\frac{1}{\Phi} J^\mu J_\mu + \nabla^2 \Phi = \frac{1}{\Phi} J'^\mu J'_\mu \quad (13)$$

$$\nabla^2 \Phi = 0 \quad (14)$$

The electromagnetic potential A_μ and J_μ represents electromagnetic four current. equation(12) and (13) relate the electromagnetic potential A_μ and electromagnetic four current J_μ with the gravitational potential Φ in a way that is gauge invariant.

$$\frac{A'^\mu A'_\mu}{\Phi} = 1 \quad (15)$$

$$\frac{J'^\mu J'_\mu}{\Phi} = 1 \quad (16)$$

The laplacian $\nabla^2 \Phi=0$ implies that the left hand side and right hand side of equation (12) and (13) are equal these claims are crucial aspect of the theory.

Event Horizon Area: The work Stephen Hawking and Bekenstein provide a fascinating and direct connection between area and entropy of events horizon of a black hole. Their work laid the foundation for our understanding of black hole thermodynamics, particularly the concept of event horizon entropy ref[1] and ref[5].

$$A = \pi R^2 \leq \frac{\Lambda^2}{2n} \quad (17)$$

Equation (17) shows a relationship between area of event horizon and Ricci scalar curvature in which the area of the event horizon has upper bound and this implies the Ricci scalar curvature is also bounded above. In the theory of general relativity cosmological constant is responsible for accelerated expansion of the universe and also stands for dark energy but in this article it represents energy scale and upper for event horizon and lower bound for gravitational potential energy.

$$\Phi(x) \geq \frac{\Lambda^2}{2n} \quad (18)$$

It should be noted that Ricci scalar curvature and stress-energy scalar curvature will be used synonymously through out this article.

Event Horizon Entropy and Entanglement Entropy:

AdS/CFT correspondence and the holographic principle laid the foundation for understanding entanglement entropy in the context of black holes and the intersection of gravity, thermodynamics, and quantum mechanics ref[6]. p represents momentum probability state and q this also represents Momentum probability State for the anti particle. Where $e_n = e_1 + \dots + e_3$ is Clifford algebra bases. we can relate it to Pauli matrices thus, $\sigma_n = \sigma_1 + \dots + \sigma_3$. Now we can look at the spin correlation conditions: if the spin of the particle probability momentum state $p = p_1e_1 + p_2e_2 + p_3e_3$ and the anti momentum probability state $q = q_1e_1 + q_2e_2 + q_3e_3$ are the same then $p-q=0$ otherwise $p+q=1$. Entanglement Entropy of black hole within this framework is defined thus $p + q = \sigma_1(p_1 + q_1) + \dots + \sigma_3(p_3 + q_3)$ and Event Horizon Entropy defined as $T^2 = p q$, Where $p q = p_1q_1 + p_2q_2 + p_3q_3$. We will focus on the x direction $p + q = \sigma_1(p_1 + q_1)$.

$$\frac{x^2}{2} = \frac{p + q}{pq} \quad (19)$$

$$\frac{\alpha^2 m^2}{2} = \frac{p + q}{pq} \quad (20)$$

$$\Phi \geq \frac{\Lambda^2}{4} \quad (21)$$

$$T \frac{\partial^2}{\partial x^2} \psi(x) = T^2 \psi(x) \quad (22)$$

Using the Taylor series expansion, we can solve the equation (22) around $x = 0$. Assuming $\psi(x)$ is analytic at $x = 0$. $\frac{\partial^2}{\partial x^2}$ is the second derivative with respect to position (x)

$\psi(x)$ is the wave function and T represents scalar Stress-Energy curvature/ scalar Ricci curvature which is the spring constant or stiffness .

$$\psi(x) = \psi(0) - \frac{x^2 T^2}{2} \psi(0) + \dots \quad (23)$$

$$\psi(x) = \psi(0) - \frac{\alpha^2 m^2 T^2}{2} \psi(0) + \dots \quad (24)$$

Equation(23) is a solution to equation (22) for massless spin half photon and its anti particle, but equation (24) is the solution for massive spin half particles and anti particles such as spin half positive charge Z boson, electron, electron neutrino and their anti particles. Where α represents coupling constant and m is mass

$$\Phi = \frac{\alpha^2 m^2 T^2}{2} \quad (25)$$

$$\Phi = \frac{T^2 x^2}{2} \quad (26)$$

$$\Phi = p + q \quad (27)$$

- “The laws of physics are invariant”

Since the Galilean transformation of Newtonian mechanics to Einsteinian relativity. Motion has been relative and the laws of physics hold true. If we consider non relative motion the laws of physics are still intact. Now let us reconsider the decay of spin zero particle into electro-positron pairs, the decay of photon into spin half photon and its anti particle, and

the decay of Z boson into spin half positive Z boson and its anti particle in a non relative manner, if we put either of the pairs inside the black hole and the other outside the event horizon of a black hole. I claim that the laws of physics outside and inside black hole are the same. Equation (25) and (26) show how Gravitational potential energy is related to the curvature for massive particles such spin half positive Z boson, electron and electron neutrino and their anti particles, and massless particles such as spin half photon and its anti particle respectively. equation (27) shows how gravitational potential is related to entanglement Entropy. The gravitational Potential energy plays a crucial role in shaping the event horizon.

When either of these particles is outside the event horizon and the other inside the event horizon gravitational potential energy causes the event horizon to expand or stretch. This expansion allows the particle to be "accommodated" within the event horizon, effectively preserving the entanglement between particle pairs. The preservation of entanglement is a fundamental aspect of quantum mechanics. When two particles are entangled, their properties become correlated, regardless of the distance between them. This information transmission is facilitated by the stretching of the event horizon, which allows the particles to remain correlated.

Black hole Complementary postulated the Idea of stretch horizon Ref[2] but the concept and mechanism in this article are different.

EPR=ER model conjectured that wormhole exist between a maximally entangled states of two black holes that form complex EPR pair ref[3] doesn't not allow superluminal signals whereas this article heavily depends on the idea of faster than speed of light.

EPR=ER is a suggested solution to AMPS model that claims The event horizon is a destructive boundary where information is lost Suggesting that Firewalls exist at the event horizon of a black hole and information is destroyed at the firewall, rather than being preserved .Ref[4]

Summary and Conclusion

- The framework presented in this article provides a novel approach to reconciling black hole information paradox by putting forward three postulates where a steady ground state is inherent property of black hole, the speed of light is quantized, and the laws of physics hold true across the event horizon.

- This theoretical framework bridges the gap between general relativity, quantum electrodynamics, electro-weak theory and the mysteries surrounding black holes, dark matter, and dark energy.
- I show how speed of light is related to the power of Ricci Scalar curvature tensor or stress-energy scalar tensor and their connection to area of event horizon of black hole.
- Through the equations and constraints derived in this framework, I demonstrate how photon decays into spin-half photon, neutral Z gauge boson decays into spin half positive Z boson and their anti particles under extreme gravitational environment of black hole and also predict the existence of a spin zero particle whose mass is equivalent to mass of electron. I believe these are possible candidates for dark matter.
- I show how Gravitational potential energy is connected to entropy of event horizon and entanglement entropy ensure that the entanglement between the entangled pairs are intact.
- Further investigation will incorporate quantum chromodynamics and also explore its cosmological implications which will advance the frontier of knowledge .

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the mighty hands that write beautiful equations that only a feeble mind can understand hallowed be thy name.

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