Unconventional reconciliation path for quantum mechanics and general relativity

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Unconventional reconciliation path for quantum mechanics and general relativity

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Abstract

Physics in general is successfully governed by quantum mechanics at the microscale and principles of relativity at the macroscale. Any attempts to unify them using conventional methods have somewhat remained elusive for nearly a century up to the present stage. Here in this study, a classical gedanken experiment of electron-wave diffraction of a single slit is intuitively examined for its quantized states. A unidirectional monopole pair (MP) field as quanta of the electric field is pictorially conceptualized into 4D space-time. Its application towards quantum mechanics and general relativity appears consistent with existing knowledge in physics. This considers a multiverse of MP models at a hierarchy of scales. Einstein's gravity is then defined to be of circular acceleration in time reversal mode to an overarching MP field precessing into forward time. Such descriptions provide a credible intuitive tool for physics applications in general. It can be further assessed using conventional methods, perhaps in incremental steps and this warrants further investigations.

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1.0 Introduction

Since the late 1800s to early1900s, knowledge acquired in increments for the microscale with the advancement of proper experimentations has come to successfully form a fundamental theory of the atomic state known today as quantum mechanics. An unexhausted list of scientists that contributed to the development of the theory during this period of time can be found in any common textbook. It was only during the 1920s that the theory was fully construed in what came to be widely known as Copenhagen interpretation, a phrase attributed to Niels Bohr and Werner Heisenberg [1]. The interpretation relates to the fundamental level, where both particle-like and wave-like characters' exhibit wave-particle duality. In addition, neutral to charged particle-like properties possess superposition state of spins in probabilistic distributions. Both of these quantum features appear somewhat counterintuitive to everyday notions offered by classical mechanics. In order to account for each of the weirdness of quantum mechanics, other alternative versions like Everett's many-worlds interpretations, quantum Bayesianism, De Broglie-Bohm theory among a few others exist. But these are not as popular as the Copenhagen interpretation based on experimental outcomes conducted so far.

Coinciding with the development of quantum mechanics in which Albert Einstein also played a key role in defining the particle property of light waves as photons [2], he further formulated his two prominent relativistic theories [3]. Special relativity accounts for constant lightspeed of wave-particle duality in a vacuum for all accelerating inertia frames of reference. Likewise, it denotes mass-energy equivalence for matter into space in one of the most famous equations in physics, $E = mc^2$. Their combination with quantum mechanics paved the path for the emergence of the quantum field theory (QFT) and this provided the link between the microscale and the macroscale or the classical level (Fig. 1). The process first began in the early

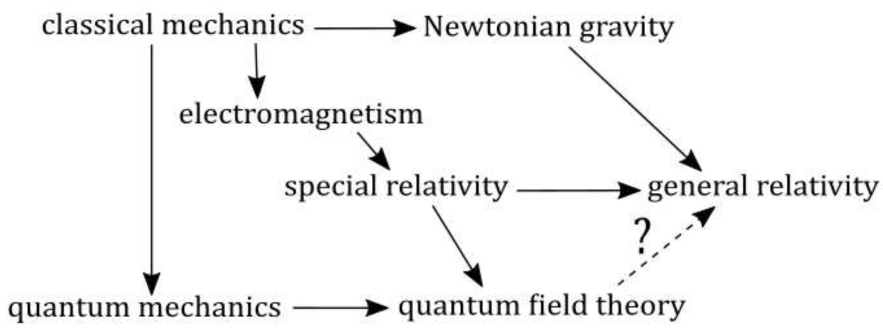

Figure 1. A simplified flow diagram demonstrating the gap in conventional methods towards the unification process of quantum mechanics and general relativity.

1930s with Paul Dirac's initial proposition of the existence of antimatter [4] in the form, $e^+ e^- \longrightarrow 2\gamma$, where an electron annihilates with its antimatter to produce two gamma rays. Such a prospect was further promoted by Richard Feynman [5] in the late 1940s using path integral diagrams, where particles couple to their antimatter to generate different force types like electromagnetism, weak and strong nuclear forces. Except for gravity, the combination of the particles and forces in accordance with experimental findings was successfully completed over the next few decades through the development of the QFT known as the Standard Model (SM) [6]. The SM theory of elementary particles employs very complex mathematical formulations to account for a plethora of particle types observed in high energy experiments. Its final prediction successfully culminated in the discovery of the Higgs boson in 2012 [7], where its existence was predicted in the mid-1960s [6]. Depending on their spins, charges and masses, the fundamental particles in the SM are categorized either as fermion or boson types. The bosons are of whole integer spin (0 to ± 1) and these are considered to have been generated from the coupling of fermions and their antimatters (i.e., particles of ±1/2 spin to other fractional spin types). The bosons mediate the main field forces of electromagnetism, weak and strong nuclear forces. A different boson type of spin 2 (graviton) is assumed to mediate gravitational force but this has not been detected yet in experiments [8]. Its eventual discovery and incorporation into an extended SM is expected to provide the possible unification path of quantum mechanics and general relativity at the fundamental level [9] (Fig. 1). However, one major constraint to such endeavor is that gravity is envisioned to weakly manifest at the Planck's length of approximately 10 cm^{-34}, a scale of very high energies not accessible yet in current experimental undertakings [10].

At the macroscale, Einstein's other landmark theory of general relativity successfully equates Newtonian gravity to acceleration with respect to an inertia frame of reference in what came to be known as the equivalence principle [11]. For an observer in an accelerated frame of reference, gravity is known to curve space-time fabric based on the light paths defined by special relativity (Fig. 1).

Overtime, experimental findings and new theories have evolved to affirm the accepted common knowledge in both quantum mechanics and general relativity as the two pillars of physics at two extreme scales. To date, any attempts to unify them using conventional methods such as the QFT applications of the SM or quantum gravity remained fairly constrained since earlier attempts by Einstein in the 1930s [12]. One major hurdle to such quests is that these methods are exclusively grounded on abstract mathematical tools that are largely driven by empirical data or vice versa. Thus, to conceptualize a four-dimensional (4D) space-time or 3D space plus 1D time is severely constrained. For this novel undertaking, a non-mathematical approach of a 4D space-time model is considered and this is briefly outlined below.

A classical Einstein's gedanken experiment of electron-wave diffraction of a single slit [13] is pictorially examined for its quantized states. Condensed electric field, **E** of the wave diffraction generates a unidirectional monopole field (UMF) as its quanta [4]. The UMF consists of a monopole pair (MP) field of an elliptic shape in precession mode into forward time. Its dissection linearly along inertia frames of magnetic field, **B** generates circular Bohr orbits (BOs) in degeneracy. These form quantized states into extra dimensions for the orbital paths in thermal equilibrium to the MP field. Precession or acceleration of the orbital of a circular motion is of time reversal mode due to gravity and this balanced out by precession of the MP field. The process sustains the equivalence principle along BOs of time dilation in straight paths. All such descriptions offer an MP model into 4D space-time of a rosette shape. Its application to both the microscale and macroscale for a multiverse at a hierarchy of scales appears consistent with existing knowledge in physics. In this way, the model offers one possibility to consolidate and unify physics pertaining to both quantum mechanics and relativistic theories. Its adaptability as a probable intuitive 4D space-time model to physics applications in general would depend on the testing and possible outcomes of its proposed design. This is outlined in this study for both the microscale and the macroscale and they warrant further investigations.

2.0 Conceptualization process of an MP model

The conceptualization path of the MP model is attempted from a classical gedanken experiment of electron-wave diffraction of a single slit. First, the process is devised using pictorial demonstrations. Second, the model is validated by applying a generalized renormalization process based on common knowledge in physics. Third, its notable limitations are examined with suggestions offered on how these can be intuitively accommodated into a probable state of 4D space-time. The final outcome offers a dynamic intuitive tool and this is applied to explore physics in general from the microscale to the macroscale wherever applicable.

2.1 A pictorial demonstration

An observer at a slit sees ripples of spherical waves receding into forward time for an emitting electron source (Fig. 2a). The electron possesses both isospin, I_z and energy-momentum, Φ. On expansion, the former is projected as arrow of time, $\vec{I}$ in asymmetry of unidirectional and this is dissected perpendicularly along inertia frames of **B** into straight paths. The condensed boundary of **E** insinuates an UMF and this consists of multiple MP fields (Fig. 2b). The emergence of orbital structures within an MP field somewhat mimes the UMF background in thermal equilibrium (Fig. 2c). The dissection of the orbitals along the inertia frames is then confined to Φ and these form quantized states of BOs. Into extra dimensions, the BOs are of degenerate states in time dilation, $I_{z\|}$ mode to $\vec{I}$ due to gravity (Fig. 2d). Precession of the MP field into forward time of a circular motion is equally balanced out by the orbital's precessions into time reversal mode. The former mimics a clock face, while the latter is interpreted to be of Einstein's gravity such that the BOs sustain time dilation along straight paths in accordance with the equivalence principle and special relativity. In this way, both fields and particle-like properties in superposition state are sustained at n-levels of BOs into extra dimensions (Fig. 2d). Increase in the dimensional energies of the vacuum state towards the nucleus somehow coincides with the emergence of the orbital types in the order, s → p → d → f and so forth. During light

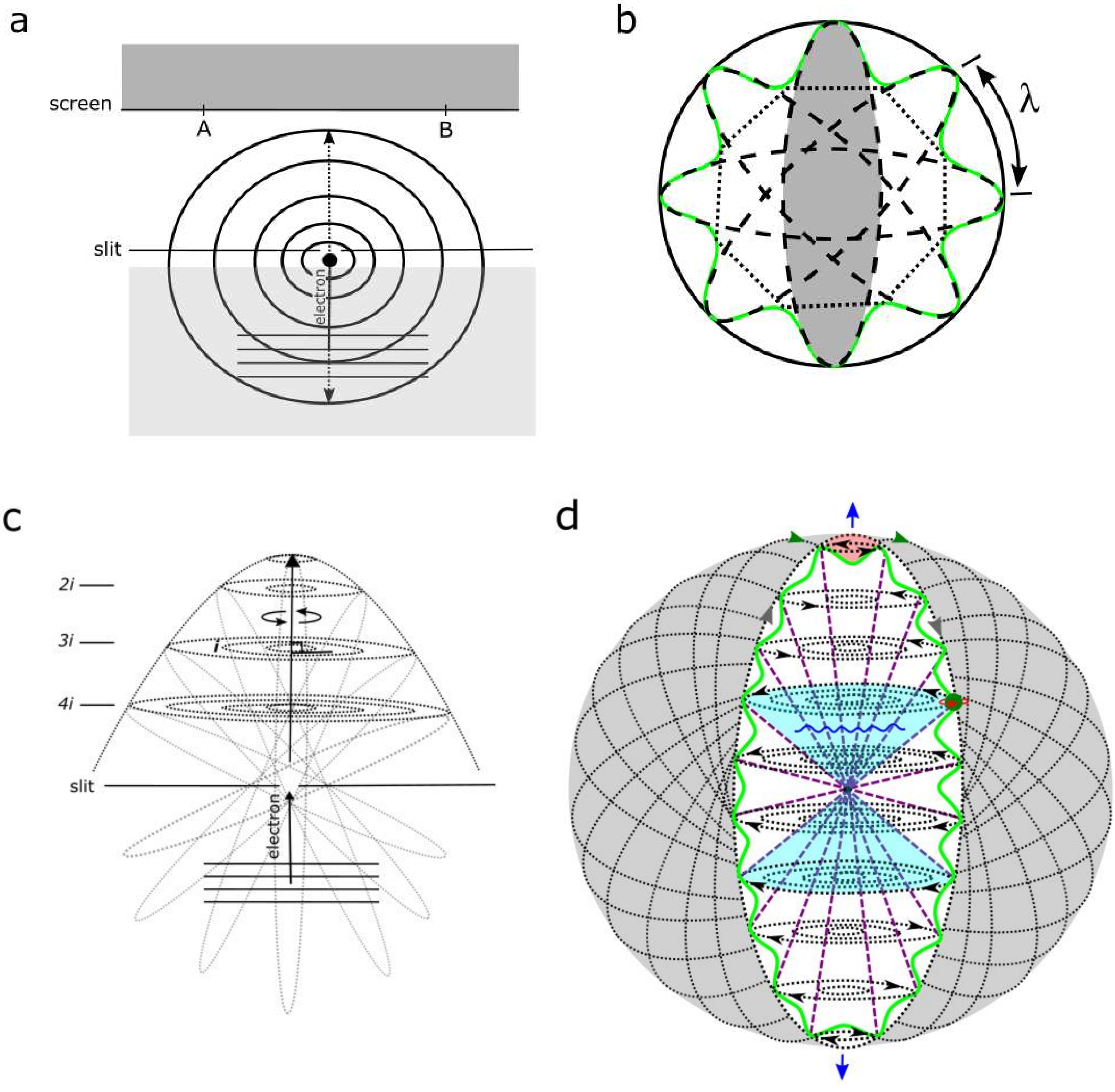

Figure 2. A step-by-step conceptualization path of the MP model. (a) Expansion of the electron-wave diffraction from an electron source through a single slit towards detectors A and B. (b) $\vec{I}$ in asymmetry is incorporated by the UMF (green loop) beneath the surface of a sphere and this includes the emergence

of an MP field (gray area) into 3D space. An octet shape of inertia frames is enclosed within a circular **E** and coherence is epitomized by the wavelength, λ for conservationism. (c) Emergence of orbital structures within the MP mimes the UMF background in thermal equilibrium. These are quantized along BOs of the **B** and this forms degeneracy and into extra dimensions, n_i. (d) The MP field is transformed into 4D space-time of unidirectional of a rosette shape in flat space. The orbital paths (pink dotted lines) of a point particle (green circle) such as an electron are quantized along the BOs. Miniature Ψ (blue wavy curve) of gravitational wave type traverses the orbital paths. The electron transition between two orbitals from point $x \to \hat{x}$ (pink area) equates to $\pm h$ of Planck's radiation (i.e., 6.626 x 10^{-34} joules x second) for the MP field (white area) at minimal well potential. This offers infinitesimal steps for precessing MP field of a clock face (green arrows) and in turn breaks time reversal symmetry imposed by gravity. In this way, superposition state, $\pm\frac{1}{2}$ magnetic spin (m_s) (navy colored cones) is attained along the BOs in time dilation and in accordance with Pauli exclusion principle. Planck's radiation then sustains $\vec{I}$ (blue arrows) in asymmetry and this mime the 2nd law of thermodynamics, while conservation is assumed for the microscale (green wavy loop). All these descriptions allude to the dynamics of an MP model (gray area) into 4D space-time in flat space.

interactions, the mass-energy equivalence of $E = mc^2$ and superposition state, $\pm\frac{1}{2}\, m_s$ are sustained along the BOs for a photon miming the MP model (Fig. 2d) akin to a Dirac process. Planck's radiation then encompasses $\vec{I}$ at a minimal energy level and this breaks time reversal symmetry imposed by gravity in the form, $E = nhc/\lambda$ towards extra dimensions. Singularity at the Planck's scale is defined by $i\hbar$ with i equal to a point particle or point-boundary of minimal potential well of the orbital. The orbital's precession between two points then insinuates h (Fig. 2d) and this is given by $h/2\pi$ or $\hbar$. All such descriptions relate to the dynamics of the MP model and this somewhat mimes an electron cloud model into 4D space-time. Its connection to a one-electron atom such as hydrogen is applicable to a precessing MP field and perhaps multiple MP fields for multielectron atoms. The electrons probability distributions along the orbital paths of the cone shapes (Fig. 2d) are attained in accordance with Pauli exclusion principle. With these explanations offered, the model's compatibility to a renormalization process and limitations are explored next.

2.2 A generalized renormalization process

The conceptualization path of the MP model can be conceived in accordance with common knowledge in physics. Commencing from the electron source towards the generation of space-time, the process is conceived by a triple integral in the following manner

$$\int_{-\infty}^{\infty} dI_z d\phi \rightarrow \int_{-\infty}^{\infty}\int_{0}^{\pi} nI_{z\|} d\phi d\Omega \rightarrow \int_{-\infty}^{\infty}\int_{0}^{\pi}\int_{0}^{2\pi} nI_{z\|} d\phi d\Omega d\theta \qquad . \qquad (1)$$

Perpetual rotation of the UMF insinuates 4D space-time and this is defined by h in infinitesimal steps at the microscale for the circular precession of the MP field given by 2π. Gravitational time dilation, $I_{z\|}$ is attributed to the quantized states of BOs at the n-levels. The BOs are of degenerate states and these appear perpendicular to the principal axis, $\vec{I}$ of the MP field in asymmetry (Fig. 2d). Non-relativistic position of a particle along BO into 3D space is defined by the spherical polar coordinates (Ω, Φ, θ). The symbol Ω equates to the number of configurations of the orbital's precessions within the MP field in a circular motion. Φ is the stress-energy momentum of BO from competing forces of gravity and precessing MP field into forward time. θ is the angle between $I_{z\|}$ and $\vec{I}$ in accordance to the orbital structure and with respect to singularity at the electron source. Any point particle in situ of the MP model and beyond Planck's energy level assumes $\pm\frac{1}{2}\,m_s$ in superposition state (Fig. 2d). The normalization of Equation 1 then takes the form

$$nI_{z\|}\int_{-\infty}^{\infty} d\Omega d\phi d\theta = 1 \tag{2}$$

where the integral incorporates the path covered by the particle in orbit and is of time invariance for the precessing MP field. From the first principle of the quantum Ψ, a particle's position in orbit is also related to the Hamilton-Jacobi relationship of the type

$$nI_{z\|} = abc\Omega sin\theta \quad . \tag{3}$$

The parameters *abc* represent the lengths of semi-principal axes of a BO (Fig. 3). The renormalization process then becomes of the generalized form

$$\frac{a^2}{x^2} + \frac{b^2}{y^2} + \frac{c^2}{z^2} \leq 1 \tag{4}$$

where the volume of the ellipsoid is given by, $v = 4\pi abc/3$. Projection of BO into extra dimension along the x-axis (Fig. 3) equates to quantized energy levels at the n-levels comparable to the MP field (Fig. 2d). Alternatively, Equation 3 can be expanded into the form

$$dxdydz = abc\Omega^2 sin\theta d\Omega d\Phi d\theta \tag{5}$$

where Ω^2 depicts precessing MP field between two stages and these overlay multitudes of the orbitals' configurations. A particle in orbit insinuates the Ψ and its magnitude is dependent on its

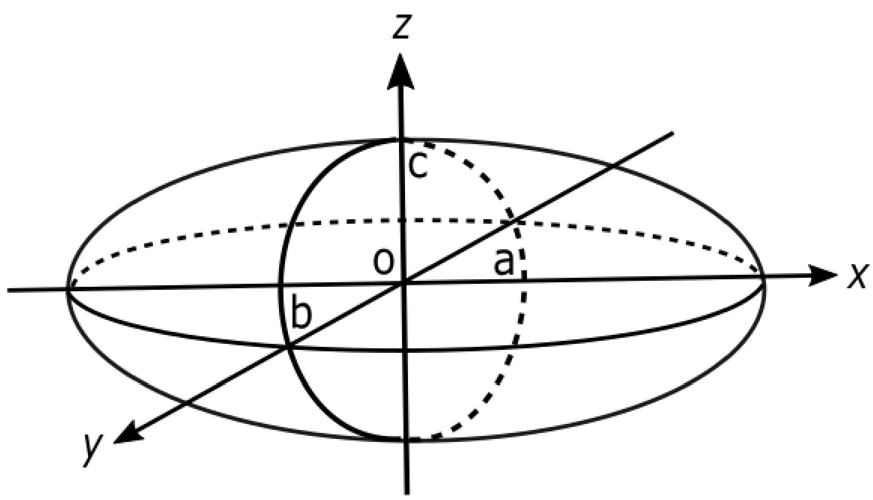

Figure 3. An MP field of an elliptic shape. The circle along the *z*-axis/$I_{z\parallel}$ is comparable to a BO, while the *x*-axis identifies $\vec{I}$ in asymmetry. In turn, the circle possesses **B**, whereas the elliptic shape is of an **E**.

size. Its transition between two orbitals from point $x \to \hat{x}$ (Fig. 2d), adheres to Born's rule in the generalized form

$$nI_{z\parallel} \int_{-\infty}^{\infty} \Psi^* \Psi d\tau = 1 \quad (6)$$

where $d\tau = dxdydz$ and the dimensions of BO defined by $nI_{z\parallel}$. Equation 6 holds true from the first principle, where the Ψ is applicable to all constants such as an electron or quantized states of BO. Such intuition forms the basis for the physical derivation of Schrödinger's equations and this is explored later in the text. Depending on the experimental set-up, external light application at a point-boundary of the MP model is expected to generate standing waves into 1D space of a continuum mode. This is given by the relationship

$$\Psi = Asin\frac{2\pi x}{\lambda} \quad \text{or} \quad Bcos\frac{2\pi x}{\lambda} \tag{7}$$

where A and B are constants for the amplitudes, while λ is projected along the *x*-axis. All these descriptions offered in this section allude to the dynamics of the MP model into 4D space-time.

2.3 Limitations

Firstly, the most obvious question arises from what powers the precession mode of the MP model into forward time in a perpetual motion and in turn violate the laws of thermodynamics? By linking precession to $\pm h$ for the MP field into infinitesimal steps, the $\vec{I}$ of time invariance is sustained at the Planck's scale. Planck's radiation then breaks time reversal symmetry imposed by Einstein's gravity in accordance with the 2^{nd} law of thermodynamics, while conservation is sustained (Fig. 2d). This offers the energy gap to restrict effective time cancellation so that life does not come to a standstill. In this case, whether $\vec{I}$ in asymmetry possibly mimes a quantum clock is open to further discussions.

Secondly, suppose Einstein's gravity is assumed to be of acceleration in time reversal mode against overarching MP field precessing into forward time as mentioned above. Observations of the electron into extra dimensions into forward measurement times then become more complex. Its intuition is perhaps akin to the probability distribution of the Ψ for the hydrogen atom into 1D space. Such explanation remains highly speculative but this cannot be effectively addressed by the principle of Occam's razor. For example, the principle underlies conventional methods and this requires empirical data, such as from point A to point B into 1D space. In the process, any intricate details, intuitions or complexities between the two points in a possible 4D space-time are overlooked.

Thirdly, even to translate the large data gathered in various interrelated branches of physics and collate them into a proper perspective of 4D space-time remains lacking. Likewise, the SM theory has been quite successful in integrating the known elementary particles and the three force types of electromagnetism, weak and strong nuclear forces [6]. However, beyond that, it appears inadequate to account for quantum gravity, dark matter and dark energy among others in the absence of new empirical data [7]. In the absence of new insights offered by experiments conducted so far, whether a 4D space-time model could address physics beyond the SM remains open to further discussions.

Finally, in theoretical physics applications, a 4D space-time is abstractly referenced by the coordinates, x, y, z and t. Somehow to relate such information to a proper model mimicking the physical world remains lacking. For this unconventional approach, the visualization of the MP model into 4D space-time and its compatibility to a generalized renormalization process is established in the preceding subsections. In the subsequent sections, the model's applicability to symmetry is conceived first before examining its relevance to existing knowledge in physics for both the microscale and the macroscale wherever applicable.

3.0 MP model versus symmetry

Symmetry at the fundamental level is governed by the Noether theorem and this assumes energy conservation. Its application to physics requires the existence of both matter and antimatter as first proposed by Dirac [4] for the electron-positron pair. Evidences of antimatter are provided by the discovery of positron [14] and stern-gerlach experiment of $\pm\frac{1}{2}\,m_s$. Beyond that, other empirical data for the existence of supersymmetric partners or microscale black holes are still lacking [7, 15]. While these are still being investigated into ongoing research developments, an intuitive demonstration of symmetry for $\pm\frac{1}{2}\,m_s$ offered in Fig. 2d is expounded in Fig. 4a. By assuming a multiverse at a hierarchy of scales, the process is applied to the solar system (Fig. 4b). Because $E = mc^2$ and the equivalence principle are sustained along the inertia frames of

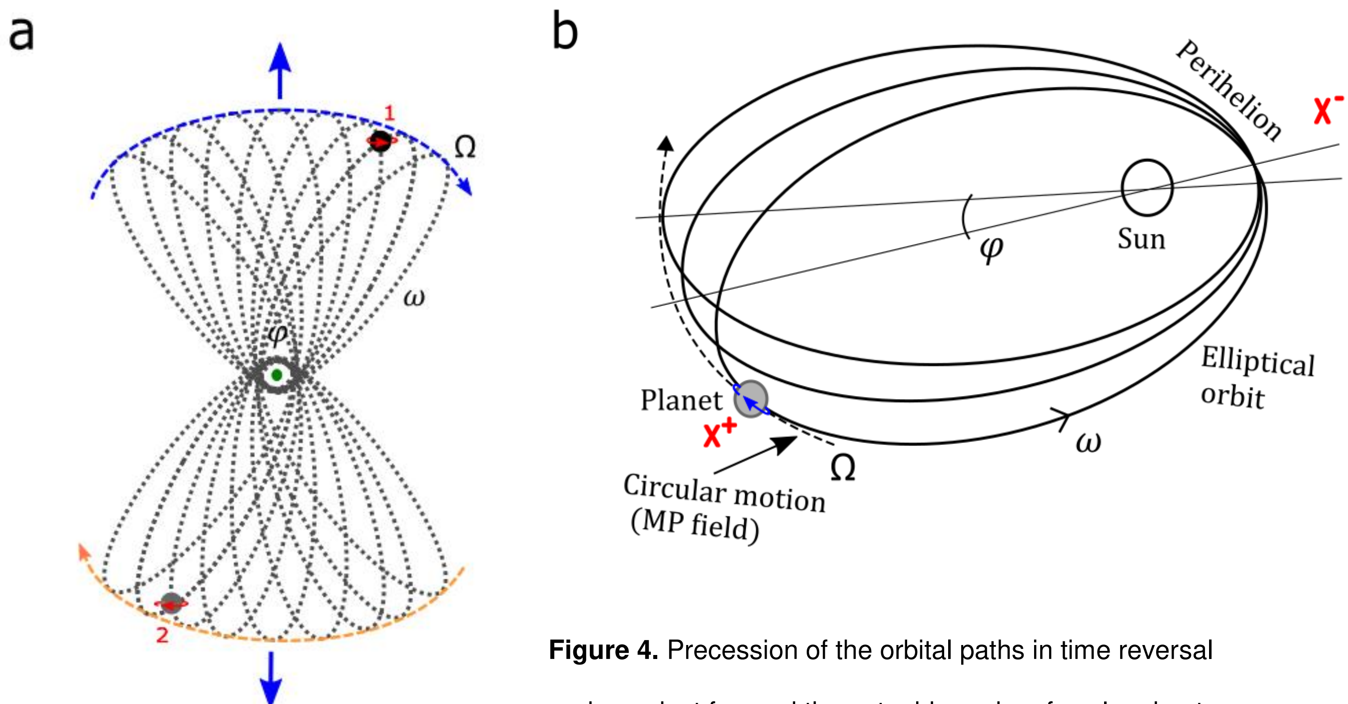

Figure 4. Precession of the orbital paths in time reversal mode against forward time at a hierarchy of scales due to Einstein's gravity. (a) At the microscale, a particle extracted in an upward direction at position 1 offers a

$-\frac{1}{2}$ spin and vice versa in a downward direction at position 2. The spins respectively assume counterclockwise directions to precessions of the MP field of time invariance (blue and brown dotted curves). (b) A similar process is perhaps envisioned at a higher hierarchy of scale for Mercury's orbit [16]. The orbital's shifts in its perihelion precessions are owed to gravity and this is balanced out by the MP field precessing into forward time based on the 2nd law of thermodynamics. Only one part of the MP is accessible to an external observer and thus, the actual motion is observed unlike the microscale in a superposition state. X^+ represents matter spinning counterclockwise and X^- is the apparent position for the antimatter field. The latter is not drawn according to spatial distance. ω = perturbation of angular velocity and φ = is the measure of magnetic flux of BOs into extra dimensions between two precession stages of the orbital paths.

BOs, the light waves or photons mime the MP model of the electron-wave diffraction during interaction comparable to the Dirac process. Thus, when the area of the applied light is more than the atomic state, both matter and antimatter in superposition state, $\pm\frac{1}{2}\,m_s$ are observable depending on the instrumental set-up. At the macroscale, the reflected light rays are less than the area of the planet and therefore, the superposition state is not readily applicable to an external observer. Instead, an MP field is assumed to normalize the outward precession of the orbital paths during orbit, while perihelion precession is attributed to Einstein's gravity balancing out forward time (Fig. 4b). Such intuitions demonstrate how symmetry in relation to energy, magnetic momentum, angular momentum, magnetic spin and center-of-mass are sustained within the MP model into 4D space-time at a hierarchy of scales. Establishing these features offers a dynamic intuitive tool that can be applied to examine physics in general for both the microscale and macroscale from an alternative perspective and this is explored next.

4.0 MP model versus various aspects of physics

In this section, the model's relevance to both the classical and quantum physics is examined. Such a process is expected to integrate a number of physics themes based on experimental outcomes into proper perspective. At the moment, this is lacking from current observations and theories without any forthcoming new insights from experiments despite the advancement of instrumentation made in recent times [17].

In Fig. 5, the treatment of the MP model to various physics themes for the microscale is demonstrated. Some of these include Planck's radiation, wave function collapse, Euler's formulation, Schrödinger equation, Heisenberg uncertainty principle, Bohr's model, electromagnetism and so forth. These are briefly expounded below in bullet points.

- *Wave function collapse:* The presence of a particle such as an electron in orbit smoothens out the precession stages of the MP field and this insinuates the emergence of a physical Ψ into 4D space-time. The Ψ is of time dilation due to Newtonian gravity and it contains all the quantum information about the system. Its intermittent transition from point $x \rightarrow \hat{x}$ between two orbital paths on a straight line is of a continuous mode for a rotating sphere. Somehow this translates to the Hermitian operator. Here, it is crucial to note that during interactions, the photons are expected to mime the MP model with the total spin 1 attained from the superposition state, $\pm\frac{1}{2}m_s$ based on Dirac process. Only at observations, the Ψ or the MP model collapses into probabilistic distributions (Fig. 5) and this somewhat resembles the translation of 4D space-time into 1D space. The output signal is then spiked in the form, $E = nhv$. The photon or electron's wave-particle duality of De Broglie relationship, $\lambda = h/p$ is also applicable to Fig. 5. For example, the momentum, $p = mv$ is attained along BO with m equal to the mass of the particle, v is its velocity and descriptions of h is offered in Fig. 2d. Such intuition considers the particle to be a physical entity and its probability distribution can somehow relate to both the photoelectric effect and wave diffraction pattern and this warrants further investigations.

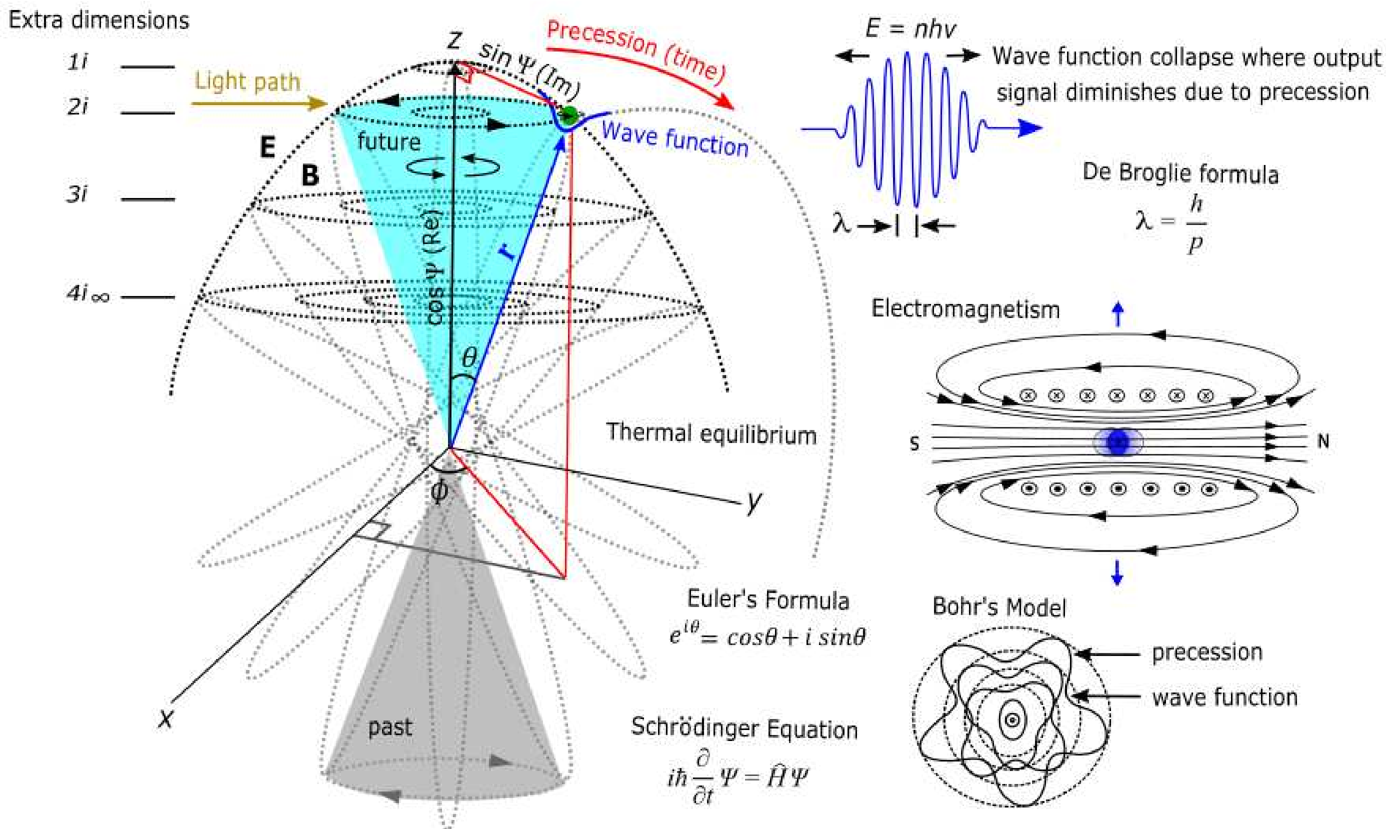

Figure 5. The application of the MP model to quantum mechanics into 4D space-time. The imaginary (Im) part of the Ψ depicts the current position of the electron at position, x before it shifts to the future or the real (Re) part at $\hat{x}$ on the z-axis. The precession of the orbital paths in a circular motion of counterclockwise due to Einstein's gravity assumes extra dimensions, *2i* etc. This is incorporated by the Euler's formula type, $e^{i\pi} + 1 = 0$, where *i* defines the electron's position, and its transition between the two orbitals given by $i^2 = -1$ at a constant radius, $r = 1$ with respect to the center of the circle, π.

Measurement into forward time reduces the Ψ into probabilistic distributions of 1D space (i.e., a wave function collapse scenario). Descriptions of the other themes provided are expounded further in the text.

- *Heisenberg uncertainty principle:* The position of the electron is described by the relationship, $\Delta x \,.\, \Delta p \geq \hbar/2$. Based on Fig. 5, the uncertainty principle appears to be an inherent property of the quantum state and not a measurement dilemma. For example, h is defined by precession of the orbital within an MP field (Fig. 2d), and this somewhat offers a level of indetermination on both the position, Δx and the momentum, Δp of the electron. In this way, the electron's position is quantized, $i\hbar$ into space as mentioned earlier (see section 2.0). Because the photon mimes the MP model, any information transfer between the electron and the photon incorporates the quantum parameters, n, l, m and m_s. The n-level relates to BOs into extra dimensions, l is defined by θ, m is attributed to BOs in degeneracy and m_s for the superposition state of the light cones (Fig. 5). Applying such intuitions, the Ψ of the hydrogen-like atoms, Zeeman effect and other odd spin types can be further explored for rotating MP model against gravity.
- *Schrödinger Equation:* The electron's non-relativistic position within the MP model is described by the $\Psi_{n,l,m}$ in time dilation. It has two parts for the spherical coordinates. The radial component, $R_{n,l}(r)$ and the angular component, $Y_{l,m}$ (θ, Φ). Both of these features are somewhat intuitively accommodated in Fig. 5, where BO is defined by ϕ as mentioned earlier. Only observation determines the outcome of $\pm\frac{1}{2}\, m_s$ in superposition state consistent with Schrödinger's cat narrative. A level of indetermination on the outcome of the m_s is offered by precession of the MP field into forward time against Einstein's gravity in time reversal mode. Time evolution of the Ψ with shift in the

electron's position (Fig. 5) is of the generalized form, $i\hbar\, \partial/\partial t\, \Psi \;= \hat{H}\, \Psi$ where $\hat{H}$ is the Hamiltonian operator for the total energy. The $\Psi \rightarrow \Psi^*$ transition between the orbital pair (Fig. 5) also obeys Born's rule for complex probability amplitudes. All these features can be further examined using conventional theoretical approaches based on the MP model.

- *Bohr's model:* The perturbed MP model is a literal representation of the Bohr's model into 4D space-time. Quantization of the orbital paths within the MP field into flat space is attained along the inertia frames of BOs (Fig. 2d). Any outgoing radiation translates to discrete energy levels in the form, $E = nhv$. As a consequence, the electron is not expected to spiral inwards towards the nucleus with continual radiation in accordance with the 2nd law of thermodynamics. But how long the electron is to be sustained in this way is open to further discussions. Similarly, decrease in the dimensions or increase in the vacuum energy levels towards the nucleus is expected to produce complex orbital types, while sustaining Pauli exclusion principle and this warrants further investigations.
- *Classical electromagnetism:* Based on the conceptualization process (Fig. 2a, b, c and d), the spherical boundary of the MP model is defined by **E**, while its quantization along BOs in degeneracy possess **B**. With conservation sustained, a particle such as an electron in orbit identifies with a Maxwell point, $i\hbar$ as mentioned earlier. Shifts in its position due to precession are incorporated into the relationship, $\nabla \times \mathbf{E} = -\partial\mathbf{B}/\partial t$ with ∇ defined by the scale of the MP model precessing into forward time of Euler's formulation (Fig. 5). Its translation to the standing waves of the electromagnetic field is provided in Equation 7. Thus, the energized light waves at different frequencies are expected to mimic the model at a hierarchy of scales for a multiverse and this is open to further considerations.

- *Quantum entanglement scenario:* Precession of the MP field into forward time against gravity offers a level of indetermination for the $\pm\frac{1}{2}\,m_s$ in superposition state along BOs for the $\Psi_{n,l,m}$ (Fig. 5). Hence, all the quantum information is stored within the MP model. Photons being massless, acquire the information from direct interactions with the model or the electrons comparable to a Dirac process. Thus, these are expected to mime the MP model by possessing spin 1 and this equates to $\pm\frac{1}{2}\,m_s$ in superposition state. The wave function collapse or quantum decoherence from the interaction of photon–photon is expected to generate the qubit, 0 from the linear combination of $-\frac{1}{2}\,m_s$ and $+\frac{1}{2}\,m_s$ in infinitesimal steps (Fig. 5). Otherwise, the qubit 1 is produced by adding either $-\frac{1}{2}\,m_s$ and $-\frac{1}{2}\,m_s$ or $+\frac{1}{2}\,m_s$ and $+\frac{1}{2}\,m_s$. In this way, the energized light waves become renormalizable comparable to the electrons (Fig. 5) and the information is transferrable to the classical scale. Within this perspective, whether a complementary photon pair at a certain frequency can be correlated in the absence of the light waves as a transport medium offers interesting prospect for quantum entanglement studies.
- *Statistical mechanics and other related themes:* The MP field encloses the orbitals in an unlimited configuration states per time and this is defined by Ω of a von Neumann entropy state (Fig. 4a and b). Both the orbital and the MP field are in thermal equilibrium within the UMF background (Fig. 2b) and the information is translated by the photons towards the classical level. Quantization of the orbitals along BOs provides the microcanonical ensemble for the entropy, S in the form, $S = k\ In\ \Omega$. The Boltzmann constant, k offers an approximation of the distributions of both fermions and bosons along degenerate states of BOs defined by Φ. Both matrix and algebraic math with

regards to Dirac-Fermion and Bose-Einstein relationships become applicable. Likewise, the BOs are of time dilation into extra dimensions of Hilbert space and this somewhat mimics a Higgs field (Fig. 2b and c). Hence, a plethora of particle types can be envisioned within the MP model in accordance with the SM and this warrants further investigations.

- *Further experimental pursuits:* The design of the MP model of a gyroscope prototype into flat space resembles a rosette shape (Fig. 2d), and this can be tested experimentally into 4D space-time. The overall rotation should mimic a clock face, while its internal orbital structures precess into time reversal mode due to Einstein's gravity. The difference in the energy scale between the two is perhaps offered by the Planck's radiation into extra dimensions, $E = nhv$. Thus, an object in orbit with a counterclockwise spin and its interaction with a light beam can be observed for a number of scenarios. 1) Lightspeed at less than the speed of the rotating gyroscope. 2) Lightspeed at almost equal to the gyroscope's speed. 3) Lightspeed at faster than the gyroscope's speed. Any successful outcomes of such undertakings is expected to ascertain some of the quantum features described above and this requires further considerations.

5.0 MP model versus General Relativity

Relativistic theories in physics form the cornerstone for cosmic observations. Einstein's name is synonymous with their development and this involves more complex mathematical paths that are construed to generally comply with the experimental findings. But to somehow translate such information into a proper perspective of 4D space-time is still lacking. Even for QFT applications, abstract mathematical tools know no physical boundaries and the predictions of extra dimensions offered by both string theories and loop quantum gravity remain unphysical and these are yet to be tested and proven in current experimental undertakings [7, 15]. With the compatibility of the MP model into 4D space-time and its wider application to both quantum and classical physics demonstrated in the preceding sections, its applicability towards relativistic theories is further explored in here. First a probable black hole scenario is assessed and this is followed by the applications of general relativity on the solar system. Other notable themes like the Big Bang and cosmic inflation are briefly explored at the end of this presentation in order to pave a new research path for their future pursuits.

5.1 A black hole scenario

Without any forthcoming information obtained directly from a black hole, its true nature remains concealed. Only light interaction with the surrounding matter is indirectly applied to predict the probable nature of a black hole [18]. At the moment, this is one of the most intensely researched topics that are currently being pursued by collaborations between countries of different continents. Satellite discs at long distances are positioned to synchronize with each other in a matter of several minutes, a feat never undertaken before [19]. One of the most important aspects of the black hole is that it is the place, where both classical and quantum mechanics are expected to come into the foreplay [18]. But trying to elucidate this process towards a possible unification path offers an enigma that continues to persist today.

In our universe, two populations of black holes are presumed to exist, each at the nucleus of every galaxy [20]. Those of stellar-mass with masses in the range of 5 to 30 solar masses and supermassive for masses in the range of 10^6 to 10^{10} solar masses. To elucidate the actual nature of the black hole from existing knowledge appears to be a very complex process for it involves a number of dilemmas such as the firewall paradox to Hawking radiation. Here, for simplicity sake, a probable nature of the black hole into 4D space-time and devoid of matter is presented based entirely on the MP model (Fig. 6). Rotation into forward time is defined by Kerr matrix,

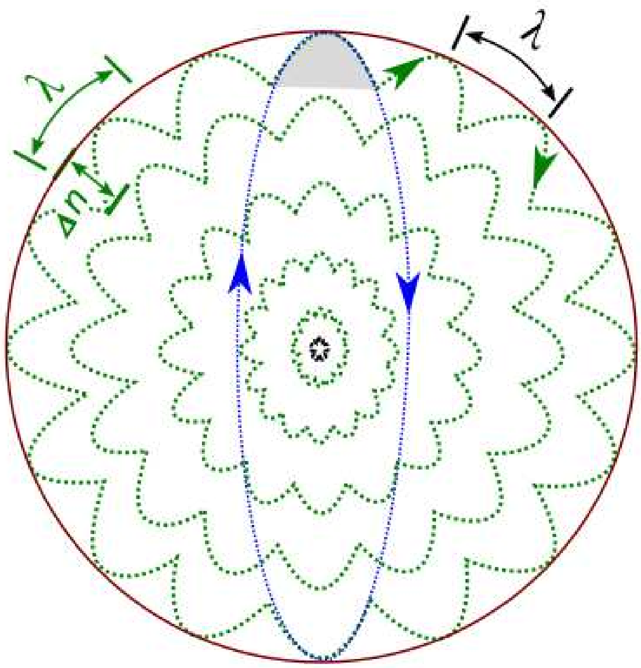

Figure 6. Application of the MP model to a black hole into 4D space-time and devoid of matter. The perturbation balance exerted by Einstein's gravity against forward time offers a static event horizon (maroon circle). Suppose light interaction mimes the MP model, this might be out of reach to observations at that scale. Any decoherence (green wavelength) of minimal energy (gray area) is expected first to overcome coherent flow (black wavelength) beneath the event horizon. The outline of the MP field is given by the blue dotted shape for the simplest scenario (i.e., a hydrogen atom), while its multiples are comparable to a multielectron atom. Blue arrows = rotating MP field and green arrows = shift in precession into forward time.

whereas the extra dimensions of inertia frames of BOs along the orbital paths are related to Schwarzschild property. The former is accorded to the precession of the MP field into forward time, while the latter becomes of extreme time dilation due to Einstein's gravity of time reversal mode. Suppose the light path is expected to mime the MP model of the black hole comparable to the microscale (Fig. 5), the magnitude of the Ψ produced might be out of reach for the instrumentation on Earth. But the emergence of the Ψ in the absence of matter is severely constrained. Thus, for a correlated photon pair interacting with the transition of the point $x \rightarrow \hat{x}$ between two orbital paths about the event horizon (Fig. 6), might be intercepted for observation. But whether such information is decoded first by decoherence prior to observation or this somehow translates to gravitational wave types noted for a binary black hole merger [19] is open to further discussions.

Comparably, a person falling into the black hole may never get the chance to reach singularity if one's body becomes elongated or 'spaghettized' along the orbital paths into extra dimensions of time infinite. Any outgoing information might be possible depending on whether a Ψ is insinuated by the presence of matter (e.g., Fig. 5). However, decoherence of the primary photons from interaction within the secondary photons within the accretionary discs of the event horizon might complicate the process from explanations offered for the entanglement scenario in the preceding section. Whether such intuition might constrain both the firewall paradox and perhaps Hawking radiation offers an interesting perspective for further considerations.

5.2 The solar system in a multiverse

Based on the Nebular hypothesis, the solar system evolved from a cloud of dust and gases immediately after the Big Bang. Suppose the planetary bodies were formed within an UMF of the sun, a likely scenario is offered in Fig. 7. In this case, whether the stability of the solar system space is sustained from interactions with others of similar type remains an open question not pursued here. Perhaps the solar system forms an MP field that is somewhat in thermal equilibrium within its galactic system known as the Milky Way. Such proposition remains a possibility because gravitational time dilation due to gravity would appear to spiral inwards from external light interactions – a scenario displayed by the Milky Way. Applying this intuition, the solar system is explored for the application of general relativity.

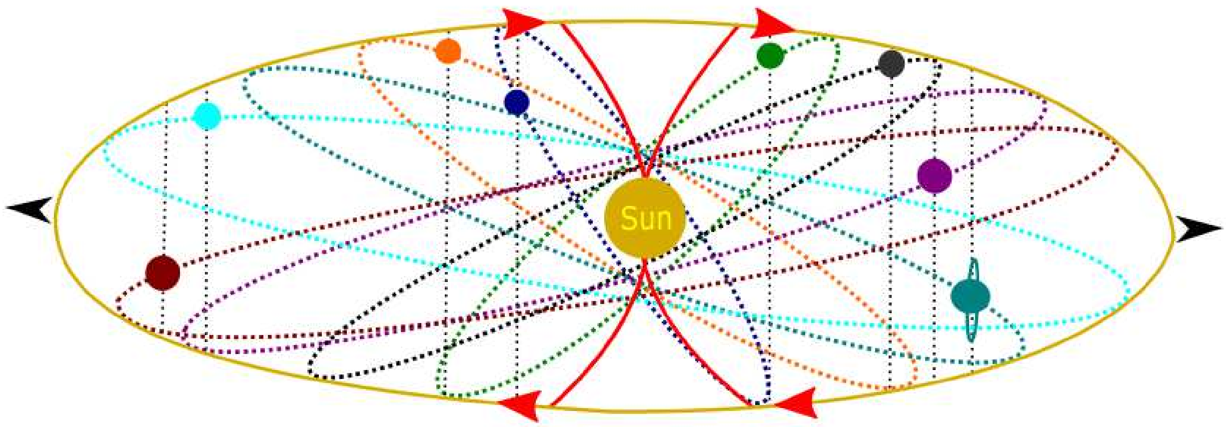

Figure 7. The application of the MP model to the solar system is comparable to a Rutherford planetary model into 4D space-time. The orbitals are quantized along straight paths of BOs (dotted lines). Divergence of the electromagnetic radiation from the sun (red curves and arrows) sustains $\vec{I}$ in asymmetry for the MP field (black arrows). The boundary (pale orange circle) indicates conservation. Note, the planets are not plotted according to its type.

In Fig. 8, an intuitive interpretation of Einstein field equation (EFE) of geometry [10] is demonstrated with respect to the MP model. The scalar curvature, R and the Ricci curvature tensor, $R_{u,v}$ describes the tensor field at the right angle of the light path interacting with the sphere of the rotating gravitational field. The path is bent at the point, where the x, y coordinates of space-time is zero for all reference frames of observation. The metric tensor, $g_{u,v}$ denotes the angular momentum of the planet's orbit with respect to the sun's gravity, G. It is applicable to both contraction, $\frac{1}{2}Rg_{u,v}$ and expansion $\Lambda g_{u,v}$ of the light path. The stress-energy tensor, $T_{u,v}$ for

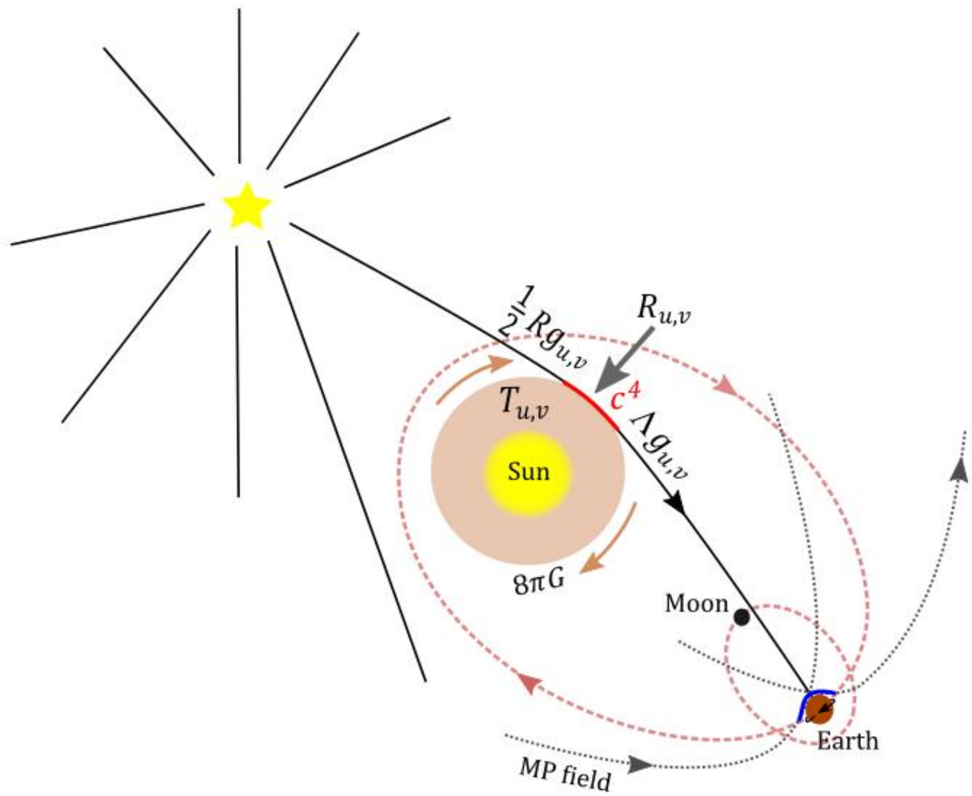

Figure 8. The application of the MP model to EFE of curved space-time. A light ray from a distant star is bent by the sun's gravity of a possible rotational mode. The path is redshifted with respect to an accelerated frame of reference on Earth (i.e., the equivalence principle). The sphere of the sun's gravitation field is localized but it determines how Earth should orbit into space-time against the precession of the MP field into forward time. The time evolution of the planetary Ψ (blue curve) between two precessing MP fields is of time dilation due to gravity and this does not affect the incoming light path comparable to the microscale (e.g., Fig. 5). Note, the Earth's orbit and its MP field are not differentiated according to scale and this is expounded further in Fig. 9.

the geodesic motion somewhat resembles the inertia frame of the BO type into manifolds of extra dimensions (Fig. 2d) and these are of gravitational time dilation along straight paths.

External interaction with the light paths sustains relativistic features of $E = mc^2$ and the equivalence principle. From these descriptions, a number of assumptions can be drawn.

1. Einstein's gravity is defined to be of a circular acceleration mode and this is related to precessing orbital paths into time reversal mode for a rotating body into space. Such definition offers a modified version of the equivalence principle and it is captured by the Euler's formula for geometry shapes (e.g., Fig. 5).
2. Gravity is localized within the MP field and is applicable to a multiverse of MP models at a hierarchy of scales. Its domain of sphere determines the precession of a smaller object in orbit including curvature of light paths.
3. The Ψ for classical objects takes a longer time frame to evolve due to extreme gravitational time dilation. Thus, it is considered negligibly small during observation at lightspeed and this somewhat sustains uniformity unlike the superposition state of probabilistic distributions for the microscale.

The above three assumptions are somewhat accommodated by the EFE and this is applicable to the development of the Ψ at a hierarchy of scales. In Fig. 9, the Ψ of a planetary body is shown by adapting Fig. 8. This considers that satellites orbit the planets in a similar fashion to how the planets orbit the sun and in turn electrons in orbit of the nucleus. Because of the $\vec{I}$ in asymmetry of unidirectional in accordance with 2^{nd} law of thermodynamics (Fig. 2d), the actual motions remain hidden to an external observer. Applying such intuitions, the plausible unification path for both the microscale and the macroscale is plotted next.

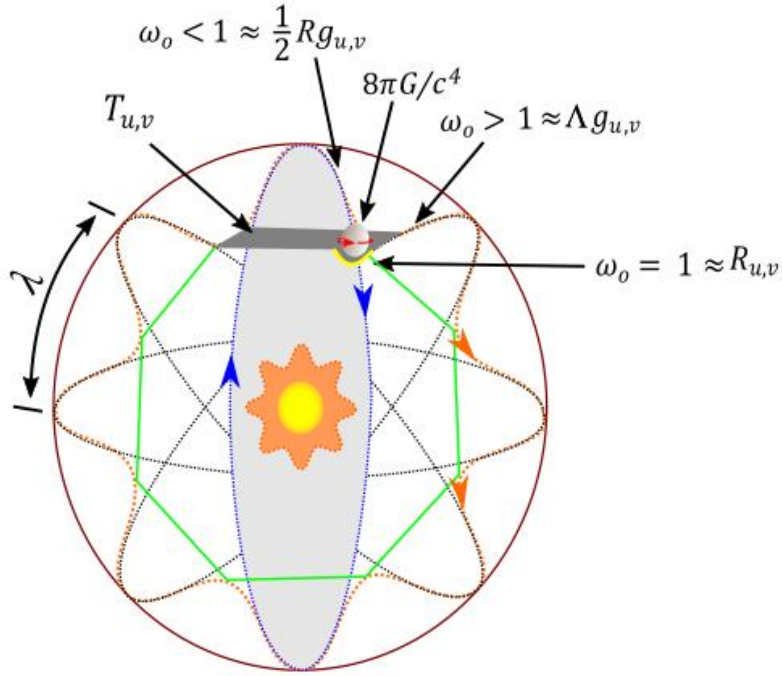

Figure 9. Application of EFE towards the generation of a planetary Ψ. The initiation of the Ψ (yellow curve) is of gravitational time dilation and is comparable to the geodesic motion. The planet's quantized orbit is given by the green outline of multidimensional along straight paths. The relationship of ω to the MP field is provided in Fig. 4, while descriptions of the other terms shown are offered in the text.

5.3 A probable reconciliation path

Pictorially, the MP model offers a tangible intuitive path towards the reconciliation process of quantum mechanics and general relativity based on the depiction of the Ψ into 4D space-time (e.g., Fig. 5 and 9). Such a path is extremely difficult to plot using conventional methods either from bottom up such as string theories or top down like loop quantum gravity. For a crude mathematical representation, Equation 2 is expanded into the form

$$i \int_{-\infty}^{\infty} (dRdTdg)_{u,v} \equiv i \int_{-\infty}^{\infty} (d\Omega d\phi d\theta)_{u,v} \tag{8}$$

where *i* refers to an object in orbit at an undefinable scale of an MP model in accordance with Euler's formulation (Fig. 5). Its momentum in both forward and reversible directions is of equal magnitude at the quantized states of BOs due to gravitational time dilation. From the geometry relationship of the proposed model, Equation 8 provides the link between the microscale and the macroscale in a multiverse. Actual observation of the motion into space-time (u,v) for both scales is attained with reference to an observer on Earth. The superposition state for the microscale constrains the motion unlike the macroscale (e.g., Fig. 4a and b). By expanding Equation 6, the planetary Ψ is given by the expression

$$8\pi G T_{u,v} \int_{-\infty}^{\infty} \left(R + \frac{1}{2} Rg + \Lambda g\right)^2 dR_{u,v} \equiv nI_{z\|(u,v)} \int_{-\infty}^{\infty} \Psi^* \Psi d\tau_{u,v} \quad . \tag{9}$$

The left side of Equation 9 relates the geodesic motion to the Ψ, where manifolds of BO into extra dimensions are defined by $T_{u,v}$ as mentioned earlier. The development of the Ψ is of gravitational time dilation, while its magnitude is defined by $8\pi G$ with gravity localized to the MP field. Such intuition is somewhat comparable to how Earth is encased by both its south and north poles. R or τ in 3D space-time simply mimes a 4D space-time. For Mercury, the perihelion precession of its elliptic orbit advances by 5,601 seconds of arc per century [13] for a body of a mass equal to 3.285 x 10^{23} kg. Suppose the formation of the arc equates to the approximate time it takes for the emergence of a planetary Ψ, this is attained at a rate of 56 seconds per year and is extremely time dilated due to Newtonian gravity. Thus, for observational purposes, a time machine is required to wind back the clock in order to register the complete Ψ that evolved over the past centuries towards the present stage. Unfortunately, there is no such instrumentation that is capable of achieving a time travel feat either into the past or the future.

With $\pm h$ projected outward towards the boundary of the MP field of time invariance, this sustains $\vec{I}$ in asymmetry (Fig. 2d). In this case, the uncertainty in the position of an object into space-time is defined by the relationship

$$\left[8\pi GT - \left(R + \frac{1}{2}Rg + \Lambda g\right)\right]_{u,v} \cong (i\hbar - mc)_{u,v} \quad . \qquad (10)$$

Equation 10 is applicable at a minimal energy level, where $\hbar$ is considered negligibly small at the macroscale. Any outgoing radiation mimes the 2nd law of thermodynamics for mass-energy equivalence, i.e., – *mc*. Alternatively, Equation 10 can be reduced into the form

$$8\pi GT_{u,v} \equiv i\hbar_{u,v} \quad . \qquad (11)$$

Equation 11 describes singularity, where Noether theorem of symmetry is sustained by the MP model into 4D space-time for a multiverse at a hierarchy of scales (see section 3.0). Perhaps, for the multiverse within a visible universe, its outermost limit is defined by the cosmic microwave background (CMB) of an MP field type. How these all fit into a probable Big Bang scenario and the accelerated cosmic inflation is presented next.

5.4 Other related cosmic themes

Based on the alternative version of general relativity offered above, dark matter and dark energy are somewhat intuitively incorporated within the extra dimensions of the universe defined by the MP model for a multiverse at a hierarchy of scales. How the Big Bang (BB) and the accelerated cosmic inflation fit into this perspective is briefly expounded below in bullet points.

- *The BB scenario*: Suppose the BB evolved from a primordial soup in uniformity, its progression towards the lower hierarchy of scales ensues in the following manner: $SO(10) \rightarrow SU(5) \rightarrow SU(3) \times SU(2) \times U(1)$ and these curtailed forces of symmetries by assuming conservationism. The Lie group $SO(10)$ is of supersymmetry for multidimensional, while the *M*-theory equates to ten spatial dimensions and one dimension of time. To an extent, both physically mime the topology of the UMF background of 4D space-time into extra dimensions in flat space (Fig. 2d). Somehow it further accommodates anti-de Sitter space in a holographic universe. Comparably, $SU(5)$ of the Lie group is accorded to the MP field undergoing time reversal symmetry breaking during precession into forward time. Out of all these manifold of dimensions, only three forces are known for the quantum state and this is represented by the gauge symmetry of the SM [6]. That is $SU(3)$ equates to the strong nuclear force, $SU(2)$ is for the weak nuclear force, and $U(1)$ for electromagnetism. Only the incorporation of quantum gravity into the SM is still lacking as mentioned earlier (see subsection 2.3). Suppose the photons assumed the inertia frames of the CMB of an MP field type during the BB, their interactions towards a lower hierarchy of scales ensue in the following descending order; galaxies → stars → planets → atoms → nuclei (Fig. 10b). The information gained by the photons is perhaps transferred through decoherence towards each scale in accordance with the 2nd law of

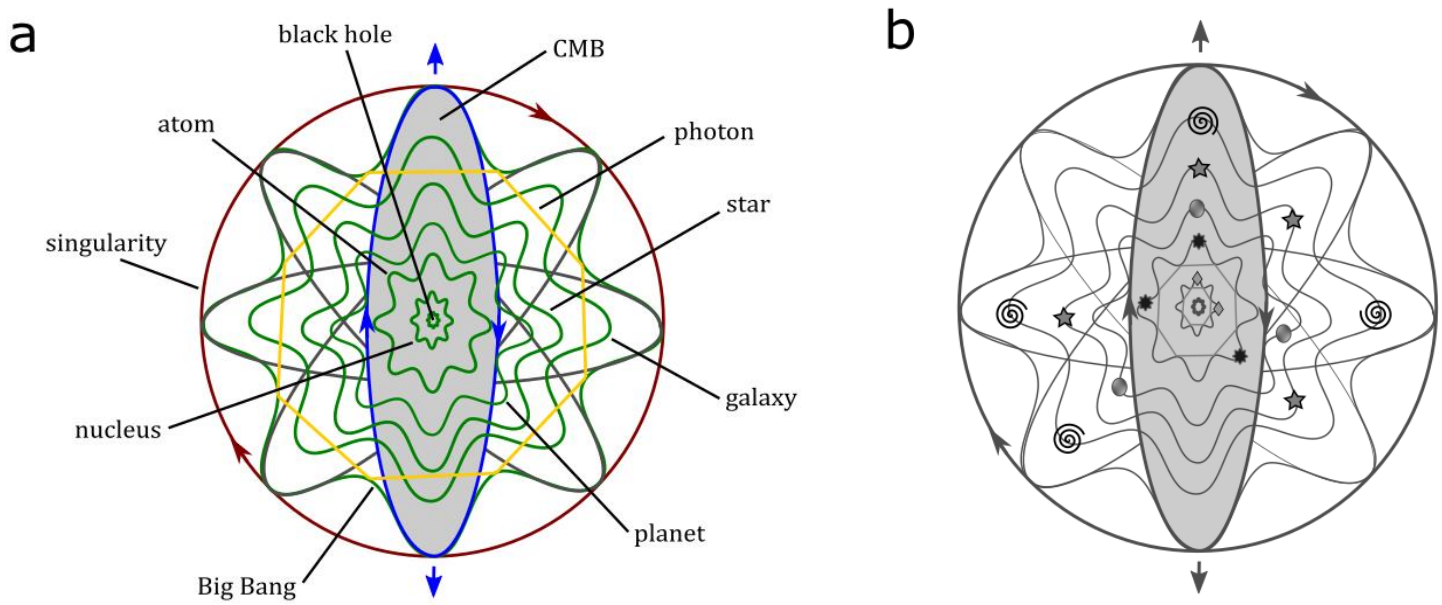

Figure 10. An idealized scenario of the BB based on the MP model. (a) Time reversal symmetry due to Einstein's gravity is broken during the BB from an initial state of uniformity or singularity. This insinuates the emergence of the MP field defined by the CMB. Cooling and regression towards the center produces multidimensional structures in thermal equilibrium. (b) Each subsequent dimension sets the stage for the evolution of bodies such as galaxy, star, planet and the atom and its constituents towards the minimal scale. A body forms when matter collides and amalgamates into extra dimensions along the orbital paths in a multiverse. The emergence of MP models at any of the dimensions and devoid of matter insinuates a black hole such as at the centers of the galaxies and perhaps for atoms.

thermodynamics (see also notes on entanglement offered in section 4.0). Thus, at the microscale, the atom is expected to store information about the BB condition but concentrate more energy comparable to the Higgs boson and gluon types. Perhaps, immediately after the BB, the energies stored would have been sufficient to trigger both nuclear fusion and fission to generate various atom types and other exotic matter. This considers the BB to be of a low entropy state within the CMB with the point-boundary of minimal potential well defined by $i\hbar$ (see also Fig. 2d) and comparable to a possible Wheeler-Feynman one-electron-universe [21]. Thus, singularity is not expected at the center for concentrated mass-energy but rather at the boundary of the MP model. But what triggered the initial process from the beginning, including how matter and time originated and whether there exist other multiverses beyond the one defined by the CMB appear to be philosophical questions that are not explored in here. Only the applicability of the cosmic inflation to the MP model is plotted next.

- *A cosmic inflation scenario*: Gravitational time dilation attained along BOs due to Newtonian gravity, severely constrains the emergence of the *Ψ* so that the light paths are redshifted (e.g., Fig. 8). Depending on the scale, the time frames can be of light years for continual precession into forward time. To an internal observer at an inertia frame of reference, the shifted frequency, *v'* is defined by the generalized form, $v' = v\left(1 - \frac{Gm}{rc^2}\right)$ into flat space with *v* is the original frequency and *r* is radius. For a localized universe of MP model precessing into forward time of a circular motion at the galactic scale, the redshift can be considerably accelerated more than lightspeed according to Euler's formula (e.g., Fig. 5) to a distant observer on Earth (Fig. 10b). This can be described in the simplified form, $z = \frac{\lambda - \lambda_0}{\lambda_0} \propto d$ with λ as the measured wavelength shift, λ_0 is the reference wavelength and *d* is the measured distance. In this case, blueshifts are fairly constrained into forward time in accordance with the Hubble constant. Such explanations could perhaps account for why ordinary matter constitutes only 5% of the visible universe compared to 25% of dark matter and 70% of dark energy (e.g., Fig. 10b). Suppose dark matter is assumed by the quantized states of BOs into extra dimensions of the MP model, this can somehow relate to weakly interacting massive particles [22] towards a higher hierarchy of scales in a multiverse. Dark energy is then assumed by interactions of light waves that mime the models into space comparable to Λ demonstration (Fig. 9). Such intuition offers one possible case why matter predominates over antimatter and this warrants further investigations.

- *Further experimental pursuits:* Comparable to the propositions offered for the microscale for further pursuits, a similar approach should be considered for the macroscale within the broad areas of cosmology and astrophysics. In this case, the external light beam is expected to be less than the area of the spinning object in orbit of a gyroscope type for a number of scenarios. 1) Lightspeed at less than the gyroscope speed, 2) lightspeed equal to the gyroscope speed and 3) lightspeed at more than the gyroscope speed. Such undertakings should also consider the black hole scenario (Fig. 6) and general relativity demonstration (Fig. 8). Any successful outcomes are expected to ascertain the model's applicability to existing knowledge in physics for the macroscale as outlined in this section.

6.0 Conclusions

Both quantum mechanics and general relativity are two extremely successful theories that account for observations made respectively for the microscale and the macroscale. But somehow their unification path continues to defy conventional methods for nearly a century despite the advancement of sophisticated instrumentation of recent times. Suppose both theories are regarded to describe realities of nature at two extreme scales but are incompatible to unify, then perhaps a 4D space-time representation is required to justify such a notion. Unfortunately, this is difficult to conceptualized using conventional methods based on trial and error basis without any prior knowledge of the applicability of a probable 4D space-time model. As a result, intuitions driven largely by abstract mathematical tools such as string theories have somewhat become more complicated to even reconcile with reality. The proposed MP model of 4D space-time offers one possibility to maneuver through such hurdle in accordance with existing knowledge in physics. Its general acceptance as an intuitive tool for broader physics applications would depend on whether its proposed design can be tested experimentally. Some of the possible outcomes can be compared to the physics themes succinctly covered in this paper for both the microscale and the macroscale.

Competing financial interests

The author declares no competing financial interests.

References

1. T. J. Hollowood. Copenhagen quantum mechanics. *Contemp. Phys.* **57** (3), 289-308 (2016).
2. R. Kidd, J. Ardini and A. Anton. Evolution of the modern photon. *Am. J. Phys.* **57** (1), 27-35 (1989).

3. J. B. Hartle. *Gravity: An introduction to Einstein's general relativity*. (Addison-Wesley, San Francisco, 2003).
4. P. A. M. Dirac. Quantized singularities in the electromagnetic field. *Proc. Roy. Soc. (London) A* **133**, 60 (1931).
5. J. P. Edwards and C. Schubert. Quantum mechanical path integrals in the first quantized approach to quantum field theory. *arXiv preprint arXiv:*1912.10004 (2019).
6. M. K. Gaillard, P. D. Grannis and F. J. Sciulli. The standard model of particle physics. *Rev. Mod. Phys.* **71** (2), S96 (1999).
7. J. Ellis. Outstanding questions: physics beyond the Standard Model. *Phil. Trans. R. Soc. A* **370**, 818-830 (2012).
8. T. Rothman and S. Boughn. Can gravitons be detected?. *Found. Phys.* **36** (12), 1801-1825 (2006).
9. Hooft, G. T. Graviton dominance in ultra-high-energy scattering. *Phys. Lett. B* **198** (1), 61-63 (1987).
10. P. de Aquino, K. Hagiwara, Q. Li and F. Maltoni. Simulating graviton production at hadron colliders. *J. High Energy Phys.* **2011** (6), 132 (2011).
11. R. Penrose. *The road to reality: A complete guide to the laws of the universe.* (Random House, Great Britain, 2005).
12. G. Amelino-Camelia. Quantum theory's last challenge. *Nature* **408** (6813), 661-664 (2000).
13. J. T. Cushing. *Philosophical concepts in Physics: The historical relation between philosophy and scientific theories*. (Cambridge University Press, United Kingdom, 1998).
14. C. D. Anderson. The positive electron. *Phys. Rev.* **43**, 491 (1939).

15. H. Baer, V. Barger, M. Savoy and X. Tata. Multichannel assault on natural supersymmetry at the high luminosity LHC. *Phys. Rev. D* **94** (3), 035025 (2016).

16. A. G. Cornejo. A lagrangian solution for the precession of Mercury's perihelion. *Int. J. Astron.* **3.2**, 31-34 (2014).

17. S. Weinberg. The trouble with quantum mechanics. *New York Rev. Books* **64** (1), 51-53 (2017).

18. N. White. Imaging black holes. *Nature* **407** (6801), 146-147 (2000).

19. B. P. Abbott *et al*. Observation of gravitational waves from a binary black hole merger. *Phys. Rev. Lett.* **116** (6), 061102 (2016).

20. R. Narayan and J. E. McClintock. Observational evidence for black holes. *arXiv preprint arXiv:*1312.6698 (2013).

21. G. N. Ord and J. A. Gualtieri. The Feynman propagator from a single path. *Phys. Rev. Lett.* **89** (25), 250403 (2002).

22. S. Algeri, *et al*. Statistical challenges in the search for dark matter. *arXiv preprint arXiv:*1807.09273v1 (2018).