The Famous Equation of E=mC² and the Spin, Quantum Momentum, are Deduced from the Dynamics of a Fluctuation between 3D and the 4th Dimension

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Abstract: ***Einstein´s pursuit for completeness can be achieved with a novel interpretation of Quantum Mechanics. The theory of space [1] presented in 2021 accomplishes the actual math with less philosophical contradictions. The famous equation of E = mC² and angular momentum S is deduced from the dynamics of a fluctuation between 3D and the 4th dimension. Some historical evolution of quantum mechanics is given combined with an analysis of how this novel theory interprets nature at the quantum level. Issues such as wave-particle duality, collapse, energy in Qantas, tunnel effect, causality at a distance of entangled particles, superposition of exclusive solutions, entropy, the arrow of time, etc. are seen in this paper. Its proposal for a conclusive experiment is also analyzed [2] hoping that in 2025, the one-hundredth anniversary of the formalism of quantum mechanics, will achieve a satisfactory interpretation.***

Keywords: theory of space, superposition, collapse, realism, locality, causality, entropy, arrow of time, quantum mechanics interpretation, Einstein, Schrödinger´s cat, Bell´s inequality, spin

1. Introduction

Next year will be a memorable one for physicists and scientists with the International Year of Quantum Science and Technology. Born´s and Jordan´s paper in September of 1925 completed the formalism of quantum mechanics (QM) that was initially begun by Max Planck in 1900 and continued with Einstein´s, De Broglie's, Bohr´s, Pauli´s, Born´s, Jordan´s, von Neumann´s, Heisenberg's and others´ breakthroughs. Despite these continuous achievements and their wonderful applications in our daily lives, the scientific community has no overall agreement in its many interpretations because they still contain some counterintuitive reasoning and no experimental verification. This tremendous progress was done in parallel with the pragmatic position of Bohr, Heisenberg et al in Copenhagen´s interpretation (among others) up to our days. David Mermin´s [3] expression "shut up and calculate" resumes very well this attitude. This great achievement comes, to a great extent, from mathematics which is based on reasoning and logic. This QM math has many orders of magnitude of success; in some cases, up to ten decimal places. The greatness of math is reflected in the comment of David Hilbert [4] about the criterion of truth and existence given by math… "if arbitrarily chosen axioms together with everything which follows from them do not contradict one another, then they are true, and the things defined by the axioms exist." Reinforce by his other quote… "However unapproachable these problems may seem to us and however helpless we stand before them, we have, nevertheless, the firm conviction that their solution must follow by a finite number of purely logical processes." Complemented by Einstein´s quote, "The most incomprehensible thing about the world is that it is comprehensible."

The physical world must be deeply logical in its foundations and the challenge is not to give up and find a way to interpret the proven equations. Fortunately, the theory of space analyzed in this paper, reveals that an intuitive model is achievable and reason and logic will be not only in the quantum math but also in its interpretation.

2. The novel interpretation of space oscillating between 3D and the 4th dimension.

This novel interpretation [1] proposes a cyclic presence in 3D. This presence will contain unit one (100% present) and it will oscillate between 3D and the 4th D. The 4th dimension is understood as Cτ, that is speed C times its period and not Minkowsky time of events. In other words, Cτ = λ; the wavelength of its energetic presence.

In Figure 1, the horizontal axis expresses the 3D space (drawn only one for simplicity) and the vertical axis expresses the 4th dimension. The "presence" is circular in side A due to the imaginary number used in the 4th dimension; i.e., the modulus of e^ i θ is constant or $\cos^2\theta - \sin^2\theta = 1$. Meanwhile, in side B, both coordinates are real numbers and the solution is a hyperbola ($\cosh^2\theta - \sinh^2\theta = 1$).

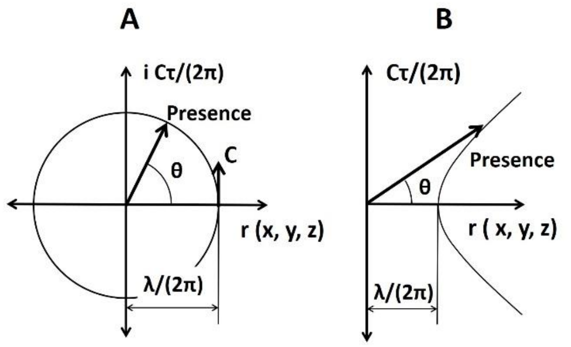

Figure 1

The speed of rotation has the value of “C” (the speed of electromagnetic waves) and its relativistic energy and angular momentum will be (for a given particle mass = m):

$$E = m\,(\lambda/\tau)^2 = mC^2 \qquad [1]$$

where τ is the period and λ its perimeter

$$E = m\,C\,(\lambda\nu) = h\,\nu \qquad [2]$$

where constant h = m C λ

$$S = \pm\, m\,C\,(\lambda/2\pi) = \pm\, m\,C\,(\lambda/\tau)\,(\tau/2\pi) = \pm\, mC^2\,(\tau/2\pi) = \pm\, h\,\nu\,/(2\pi\nu) = \pm\,\hbar \qquad [3]$$

The constant h and C in equation [2] imply that when m increments, its λ decrements as indicated by the gamma of Lorentz´s (m*γ and λ/γ). Idem to λ and τ, when there is a time dilation (decrement = 1/γ), it also implies a length contraction (1/γ) for a constant C. Note that the rotation can be randomly CW and CCW; that is the reason why the angular momentum includes the plus or minus sign. Equation [2] corresponds to one rotation; half of it (3D – 4D – 3D) can be the explanation for fermions quantum spin. Also, note that spinning energy at the 4^{th} D is Einstein´s famous equation and is orthogonal to kinetic energy (KE) in 3D, i.e., $E^2 = (mC^2)^2 + KE^2$. Total angular momentum including the 4^{th} D is also a vector addition of **S + L = J**.

The author prefers Figure 1-A than1-B because hyperbolas don´t evidence the repeatability in nature. The complex numbers used is Figure 1-A simplify the math with traditional sine and cosine or Euler´s equation, and most importantly the intermittent presence in 3D is evident with the inclusion of random sense of rotation. Once again, the need of complex numbers in quantum mechanics is evident.

3. Interpreting the first quantum equation.

Max Planck [5] gave the first huge step in 1900 with its E = hν. This simple but profound equation reveals that energy comes in quanta and varies only with its frequency 1/t; basically, a package of one fluctuation. Not its amplitude as expected by classical physics. This equation has the same importance as $E = mC^2$ that comes from the other core modern theory. In Planck´s equation, the “t” is not a time evolution; it´s the period τ of the quanta. The theory of space considers that when Planck´s action h is gradually present in 3D, it manifests as a low energy. With the same reasoning, when action h is rapidly present in 3D, it reveals a high energy. Now, energy in quanta and inversely proportional only to its periodicity of appearance in 3D will no longer be the classical link of amplitude with energy.

So, E = h/τ = (h*λ/λ)/τ = h C/λ; in other words, p = E/C = h/λ that is De Broglie´s equation [6]. And this is the way that the 4th longitudinal dimension is interpreted, λ = Cτ and not Ct where “t” is Minkowski time evolution of events [7]. One period τ or “interval” is OK but note that from the passage of time, a growing “t” or h/t doesn´t mean a progressive lower energy; aside from the issue that, what initial time is considered? This τ links with Poincare´s relativistic view; that is Delta x^2 + Delta y^2 + Delta z^2 + (i*Delta Cτ) ^{2} being invariant. Now, a smaller τ will imply a higher energy and a space contraction of x-y-z. Both core theories of modern physics are joined by τ. Even more, the quantum condition of the fluctuating presence having a speed C (λ/τ), is what gives the speed limit in 3D; the second axiom of Relativity. The quantum package can´t move farther than the distance λ in a given τ; so, particles/fields in the new fluctuation must “appear” in a place covered by the package. Another joining point between the two core modern theories.

The physical world will be represented by four longitudinal dimensions; λ, x, y and z. Hamilton´s quaternion [8], with a minor change of “i” to the scalar **l**(unitary vectors that follow **i j k** = $|\mathbf{i}|^2 = |\mathbf{j}|^2 = |\mathbf{k}|^2 = -|\mathbf{l}|^2 = +1$); three orthogonal spatial vectors plus the orthogonal 4th dimension as an imaginary scalar (Lorentz gamma factor [9] can also be used) that provides the scale value of the other 3 vectors due to the presence of energy. Lambda is the longitudinal dimension of energy, a perfect dimension that gives invariance with the imaginary i; their values in the 4^{th} coordinate axis can go up and down depending on the local energy that goes from low to high. Space, time and mass are related to the energetic presence as Einstein shows in his General Theory of Relativity [10].

Note that mass-energy, space-energy and time-energy clear up the common “spacetime” that may mislead to a dual relation of space with time. Additionally, no more bent coordinate is needed, the same cartesian straight coordinates [11] with a local scale that depends on the local and surrounding energetic sources. The 4^{th} dimension is not a vectorial axis as the other three, the addition of diverse values Cτ doesn´t contribute to a physical meaning. The actual spacetime grid that contains a coordinate Ct with some separated energetic sources will no longer be confused by the distance Ct, a separation of time multiplied by C. Also, the confusing word “flat-space” is replaced by “even space,” a space where the same scale is all around, i.e., a space without energetic sources (no gravity).

4. The next challenge, is the wave-particle duality

From Einstein´s [12] followed by De Broglie´s contribution in 1923, arise the quantum wave and particle characteristic of photons and particles, a duality that immediately presents controversy. How can a wave be a particle in the same instance? Two antagonist entities that break the core principle in philosophy, the law of non contradiction [13]. This is brightly overcome by considering the coexistence of two entities and not one entity with two non-inclusive

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presence. The physical tangible things (elementary particles) as one entity and the physical wavy space is the other entity. The crucial double slit experiment [14] put this in evidence, it can now be understood as the wavy space, huge enough to pass through both slits and later having a destructive presence between each passage; and at the same instance, the small particle that passes only through one slit. Conveniently big and small at the same instance with no conflict because it deals with two entities in coexistence. The split space continues and develops an absence in their destructive zones and, on the other hand, the particle will only be where its quantum space is available. This will condition the compact entity to behave as a diffuse wavy one; no more a confusing duality. Going further, if a detector is put across one of the slits, then, only the quantum space that contains the particle will continue and the destructive interference is no longer present. Richard Feynman´s lecture´s quote "I think I can safely say that nobody really understands quantum mechanics" can get to an end before the one-hundredth anniversary of the foundations of QM. Note that this interpretation is quite different from the deterministic De Broglie and Bohm´s pilot wave [15] which also explains this duality. This theory of space has also realism (the concept of existence independently of the observer) but with the great difference that it´s intrinsically non-mono deterministic; on every new space fluctuation, the particle has no condition of its previous 3D scenario and it acquires randomly any eigenstate. A poli-deterministic concept is different from a mono-deterministic one. Also different from an indeterministic one because it´s confined to valid states; not to any indeterministic solution.

5. The versatile quantum characteristic of multiple states

This quantum characteristic of multiple states is one of the core concepts of QM and at the same time, one of the misunderstood characteristics. The vast QM interpretations include multiple dimensions, but they don´t consider a scenario out of 3D, and that is the clue to avoid some counterintuitive explanations. The consideration that space fluctuates between 3D and the 4^{th} dimension is fundamental to understanding why energy has a discrete presence in 3D and how one valid solution can be replaced with another one. For example, the electron of the hydrogen atom is always seen as a compact one meanwhile it encapsulates the electric field of its nucleus. A multi-orbital scenario where its position is perfectly described by the probabilistic presence given by the quantum math. Since no energy is involved (radiated nor absorbed), how does the electron change from one valid orbital to another? Aside from the energy issue, the transit or path in 3D between solutions is impossible. This led to Bohr, Heisenberg, Jordan, Pauli and others to assume the superposition scenario, i.e., an omnipresent state. This assumption is based on classical waves, for example in the chord of a guitar, its fundamental frequency coexists with all their harmonics, i.e., a superposition of frequencies; no problem with that. The big issue is that quantum states are exclusive; they are one or the other. Even more, a split electron in all the orbitals at the same time is never seen; there is no diluted electron.

The linear algebra that considers that if A and B are independent solutions, then their combination will also be a solution; this only applies to inclusive solutions. That is, states that can exist together. But this useful linear algebra is perfectly applied to QM with exclusive states; why? That is because the versatility of nature needs to be managed by a tool that processes many solutions; up to this, there is no problem. The problem comes with the simultaneity, i.e., the superposition of antagonist states. The greatness of the theory of space is that it understands nature as fluctuating between 3D and the 4^{th} dimension. That ephemeral absence in 3D provides the mechanism to change between states without any external reasons. A nature that reveals in 3D its multiple states one-by-one with a probabilistic weight between them. Taking this one-by-one situation, our mind embraces linear algebra with harmony.

Note that this one-by-one scenario can´t be applied to systems that had changed; they will assume, randomly, their new states. For example, in nuclear decay, once the tunneling occurs, there is no way back (oscillation) to the old states. Idem with photons that pass a polarization filter, their old polarized information will no longer continue. Extending to Schrödinger´s famous thought experiment, the nucleus of the radioactive material is in oscillation and not the cat. The probability involved is for the decay, when the tunneling occurs, then the cat will suffer its fatal destiny.

From the historic part, in 1924 Wolfgang Pauli presented the fourth quantum number and the exclusion principle. In the next year, Werner Heisenberg gave the groundwork of matrix mechanics [16]. Sixty days after, Max Born with Pascual Jordan [17] completed the QM formulation in September 1925. In 1926 Werner Heisenberg published with Born and Jordan [18] a second paper of "Zur Quantenmechanik;" Göttingen was the cradle of great achievements. In the same year, the mathematician John von Neumann realized that a quantum system could be represented by a point in a Hilbert space and linear operators acting on it. 1926 was full of great contributions; Schrödinger gave his wave function Psi [19], a wavy mechanical approach. This function gave a more intuitive presentation of nature where waves explain the different levels of energy, and the interactions with a phase difference including the destructive interference zones proper of waves. Unfortunately, from the human perspective, Schrödinger had questionable behavior with young girls [20] and P. Jordan enroll in the Nazi party in 1933. In 1927 Heisenberg presented his Uncertainty principle [21] and in October of that year, the 5^{th} Solvay conference was realized with the victory of Copenhagen´s point of view.

6. Complexity and completeness of Quantum Mechanics.

The one-by-one appearance in 3D embraces the quantum behavior with no weirdness on observation. In those events, only the current state will be present and able to be seen as established by the "Certainty Principle" of the theory of space. No diluted action "h" nor a fraction of particle-fields all over; in other words, no superposition is present at 3D. The great controversy of the collapse or measurement problem is overcome by this theory of space. The issue that one simple state is in 3D meanwhile the complexity of the system prevails in the 4th dimension gives completeness to QM. Like being limited to looking only at the upper face of a die, the full entity can be appreciated over time when all the other faces are seen. The quantum system will present randomly in 3D all the possible states with their respective probabilistic weight. When an observation or interaction occurs, the system will change according to the event and in compliance with the conservation laws. Theories of “hidden value” can imagine that the 4th D is the dimension where to find the answers. Einstein´s, Podolski´s and Rosen´s paper in 1935 [22], can now find that Quantum Mechanics is complete; every aspect is contained in the fluctuating 3D plus 4th D. A poli deterministic nature that accomplishes the versatile roll of multiple states; of course, one-by-one! Then, the expectation value is not a physical reality; in the same way that a superposition of exclusive solutions isn´t a 3D reality. The expectation value represents the average existence of the versatile multi-states. It´s similar to thermodynamics where expectation values of pressure, temperature, etc. represent the average reality of the numerous atomic-molecular kinematics. In the quantum scale, it refers to the numerous presences in 3D.

The characteristic of the intrinsic randomness in the presence of a given eigenstate implies that time can´t be reversible. Going backward with the same random solutions is neglected, so time has an arrow of evolution. This randomness of one-by-one solution has another implication that is the presence in 3D of the Law of the large numbers over time. The one-by-one presence explains why closed systems will get closer to the average value of all the individual solutions, i.e., its expectation value. So, close quantum systems get evenly over time; their entropy stays the same or increases. Note that entropy is commonly presented as a disorder but evenness is a positive way to describe it. Also, note that the actual thought of superposition is an unchanged mixture of states, this will not be by the accumulation of cases needed to sustain the statistical law of the large numbers.

This ephemeral passage to the 4th dimension can also explain how particles can overcome a barrier, i.e., the tunnel effect. Not only that, in the 4th dimension entangled particles are local and don´t have the restriction of 3D spacing; consequently, the reasonable and logical causality is preserved even for entanglement particles very far from each other in 3D. Note that a coherent oscillation is necessary for this common passage to 3D and the 4th dimension. Now, we can understand the experimental verification that deserved the Nobel Award in 2022. Unfortunately, there is no posthumous award for John Bell [23], the creator of an inequality that makes experimentally distinguishable a local causality in 3D from a quantum nonlocality in 3D.

7. Is it verifiable?

Aside from the reasoning and logic that is accomplished by this theory of space in explaining the diverse experiments and the applicability of linear math, it´s desirable an experiment for further confirmation. Fortunately, the author gave a proposal [2] in 2022 on how to verify this theory. Quite different from many other interpretations that don´t have any proposal and are still active.

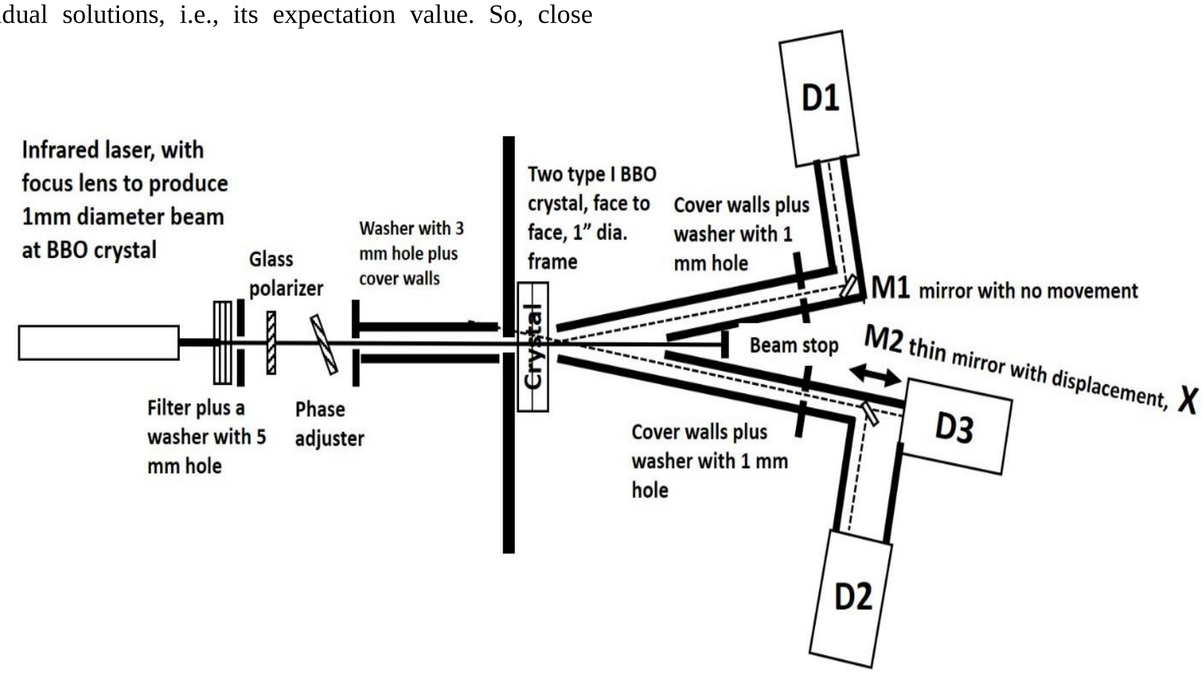

Figure 2

In Figure 2 an individual photon is split into two photons, one arriving at detector D1 to determine the time to recollect the data avoiding undesired noise. The other photon gets reflected at mirror M2 and is detected by D2 unless there is a quantum tunneling through this mirror and arrives at D3. This mirror M2 is moved in the traveling direction, fractions of its wavelength, so the probability of occurring a tunneling can be correlated with the displacement X. If the data gives a positive correlation that will be in accordance with the theory of space that establishes that the tunneling happens when the photon presence fluctuates to the 4th dimension.

8. Conclusion

The progress in fundamental physics overpasses QM with Quantum Field Theory (QFT), Quantum electrodynamics (QED), Quantum Chromodynamics, the Standard Model; excellent progress is made but from them, the last 50 years, the success is not the same. The most renowned string theory and Loop quantum gravity are still under discussion. There are also unsolved issues like black matter, black energy, collapse of the wave function, unified theory, cosmic inflation, etc. Meanwhile, progress in experimental and applied physics continued. First observation of black holes in 1964, confirmation of violations in Bell´s inequality in 1972- 1982- 2017, observations of W and Z bosons in 1983, idem to Bose-Einstein condensate in 1995, detection of gravitation waves in 2015, detection of Higgs boson in 2012, attosecond detection, MRI, lasers, superconductors, etc.

From the QM side, it seems that Everett´s many-worlds interpretation isn´t necessary to describe nature when a definition is given to the versatile quantum states. It´s sufficient for our 3D universes to be full of quantum systems bubbling into and away from the 4^{th} dimension. No problem when the probability is an irrational number; the presence is just a one-by-one scenario at a rate given by its energetic frequency.

Also, quantum math is clarified by modifying the superposition concept with probabilistic management of exclusive solutions. The wave function reflects the probabilistic amplitude distribution of its particle in its quantum space. The complex numbers express the alternating scenario where total energy and momentum are at the imaginary axis, meanwhile its space-time is at the real axis. This phase difference between some physical parameters explains why quantum math is noncommutative and Heisenberg´s Uncertainty Principle. The 4^{th} dimension (Ct) is understood as lambda of local energy and its fluctuation with the observable 3D; this will complete the realism not observed at 3D and provide local causality thanks to the passage at this 4^{th} D.

It seems that this novel interpretation of QM gives to this century-old theory completeness; Einstein´s objections are sustained by a wavy space. The theory of space provides a reasonable and logical model of the universe at the quantum scale; poli determinism, reality and locality are validated. Total energy, momentum and charge at the 4^{th} dimension will open doors to the unsolved questions.

Declarations
The author declares no conflicts of interest regarding the publication of this paper.

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