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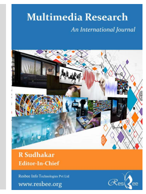

Quantum Hidden Variables and Riemann Hypothesis

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Abstract: In this paper, I explore the intriguing connection between hidden variables in quantum mechanics and the nontrivial zeros of the Riemann zeta function. Despite the apparent randomness in quantum phenomena, I demonstrate that deterministic hidden variables can coexist without violating Bell's inequalities, particularly in scenarios involving small angles. Using MATLAB simulations and a simplified space-time model, I illustrate this relationship, shedding light on the fundamental nature of quantum systems. This research not only deepens our understanding of quantum mechanics but also opens new avenues for investigating the Riemann zeta function's implications, potentially transforming our approach to both fields.

Keywords: Negative Probabilities, Quantum Mechanics, Hidden Variables, Nonlocality, Riemann Hypothesis

1. Introduction

At the beginning of the twentieth century, Albert Einstein wrote a paper on the theory of relativity [1]. Einstein firmly believed in the strict determinism of the universe and its laws, rejecting any role for probability or chance in the foundation of nature. This stance led him to disagree with the emerging theory of quantum mechanics, first articulated by Max Karl Planck and subsequently embraced by many physicists [18].

Before Einstein, including the Isaac Newton era, the prevailing belief was in the determinism of all phenomena, as cited in [7]. However, in 1927, influenced by Thomas Young's ideas, Werner Heisenberg introduced a new perspective after the double-slit experiment's findings (W.H. Freeman, 1992). This perspective posited that on a small scale, at the atomic level, events become probabilistic rather than deterministic.

As a result, a debate ensued among scientists regarding whether quantum mechanics is deterministic or probabilistic [1].

The measurement of the spin of one entangled electron predetermined the spin of the other, even when separated by a significant distance. The question at the heart of the debate is whether there exist local hidden variables between the two entangled electrons or if there are no hidden variables, and they communicate instantaneously, seemingly violating the speed of light.

Einstein's perspective likened the situation to two hands of gloves—one placed in one box and the other in a different box. The observer, separated from the boxes, opens one and determines whether it contains a right or left-hand glove. The result is then known instantaneously to the other partner. Bohr, on the other hand, rejected the notion of hidden local variables between entangled electron spins in quantum entanglement. The ongoing debate between physicists, aligning themselves either with Einstein or Bohr's ideas, persisted until the Solvay conference and the development of the Copenhagen interpretation of quantum mechanics from 1925 to 1927. This interpretation, primarily championed by Niels Bohr and Werner Heisenberg, posits that the waves of a particle collapse during measurement, functioning as a particle—an idea commonly referred to as the collapse of wave particles.

Einstein presented his final challenge in 1935 through a paper known as EPR, an acronym derived from the collaboration of Einstein, Podolsky, and Rosen [1]. The key conclusions of this work state that the quantum mechanical description provided by the wave function is incomplete, particularly when the operators corresponding to two physical quantities do not commute, or these quantities cannot simultaneously possess reality.

In 1964, Irish physicist John Stewart Bell contributed to the debate with a paper [3], asserting that if a local hidden variable exists in quantum mechanics, it can be formulated and tested using Bell's inequalities. Subsequently, in 1982, French experimentalists Alan Aspect and Paul Kwiat found

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violations of Bell's inequalities up to 242 standard deviations, providing strong scientific certainty (Hilbert, David, 1902).

The primary objective of this paper is to demonstrate the existence of a hidden variable in quantum mechanics by utilizing a space-time model. This model, implemented with MATLAB software, showcases where Bell's inequality breaks down for small angles. Notably, the model incorporates the unique concept of time having two directions, each yielding distinct outcomes.

Furthermore, this paper endeavors to reconcile the quantum mechanics debate by illustrating the interrelation between quantum mechanics and Riemann Critical lines through hidden variables and non-trivial zeros, respectively. The organizational structure of the paper is outlined as follows: Chapter two reviews the works of various scholars on quantum mechanics. Chapter three delves into the methodology, exploring how space-time behaves within the framework of Einstein's belief in local hidden variables. Chapter four presents the main results through MATLAB-generated plots. Finally, Chapter Five summarizes, discusses, and draws conclusions based on the findings.

2. Literature Review

In the initial section of this chapter, various ideas and concepts related to quantum mechanics are reviewed. The subsequent portion focuses on presenting specific results associated with the Riemann hypothesis.

2.1. Quantum Mechanics

"I think I can safely say that nobody understands quantum mechanics". This is one of the most frequently cited quotes from Richard Feynman (May 1918 – February 1988), and it is undeniably a surprising assertion coming from the mouth of a physicist.

In 1952, David Bohm wrote a paper addressing quantum entanglement, proposing the existence of a hidden variable at play in the process of long-distance communication. His idea involves a guiding wave for particles, giving them the appearance of a wave with probabilistic characteristics while being fundamentally grounded in a concealed variable.

Stephen Hawking remarked, "Quantum physics tells us that no matter how thorough our observation of the present, the (unobserved) past, like the future, is indefinite and exists only as a spectrum of possibilities. The universe, according to quantum physics, has no single past or history. The fact that the past takes no definite form means that observations you make on a system in the present affect its past."

Another aspect related to the hidden variable theory is the concept of super determinism in quantum mechanics, originally proposed by Bell. In a 1983 interview with the BBC, Bell stated, "There is a way to escape the inference of superluminal speeds and spooky action at a distance. But it involves absolute determinism in the universe, the complete absence of free will. Suppose the world is super-deterministic, with not just inanimate nature running on behind-the-scenes clockwork, but with our behavior, including our belief that we are free to choose to do one experiment rather than another, absolutely predetermined, including the 'decision' by the experimenter to carry out one set of measurements rather than another. In this scenario, the difficulty disappears."

2.2. Bells Inequality

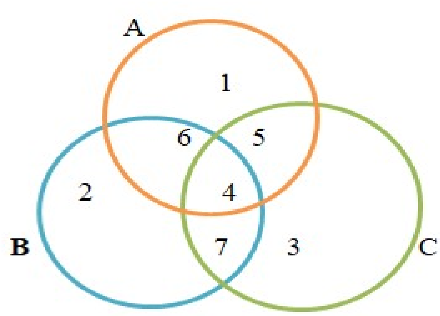

Fig.1. Bell's vein diagram, source of his inequalities

$$A \text{ not } B + B, \text{ not } C \geq A, \text{ not } C$$
$$(1+5) + (2+6) \geq (1+6)$$

$$(1+6)\ +\ (5+2)\ \geq\ (1+6)$$

There is indeed a common value for both sides: 1+6. However, 2 from sets A and C and 5 are also common values, so 2+5 should not be considered as an option for comparison on the right side of (A not C). Nevertheless, the equality sign always holds. However, according to Bell's inequality, it is violated in quantum mechanics when measurements are taken in an experiment at an angle of 45^0, as illustrated below.

$$sin^2\left(\frac{45}{2}\right)+sin^2\left(\frac{45}{2}\right)\geq sin^2\left(\frac{90}{2}\right)$$
$$0.1464\ +\ 0.1464\ \geq\ 0.5$$
$$0.2928\ \geq\ 0.5$$

This statement is incorrect, and he concluded that there is no space for hidden local variables. Niels Bohr's perspective is accurate, and Einstein's is incorrect. Quantum mechanics operates on a probabilistic basis, leaving no room for deterministic or hidden local variables. He demonstrated that we inhabit a probabilistic world.

2.3. Number theory (Bernhard Riemann Theory)

The Riemann zeta function, denoted as ζ(s), is a mathematical function defined for any complex number s that is different from 1, and its values also include complex numbers. The function exhibits trivial zeros at negative even integers, meaning ζ(s) equals 0 when s is equal to −2, −4, −6, and so forth. However, there exist other zeros known as non-trivial zeros.

In 1859, Bernhard Riemann authored a paper addressing the location of these non-trivial zeros. This topic is recognized as one of the seven Clay Mathematics Institute million-dollar prize questions. The problem holds significant importance in number theory, particularly in understanding prime distributions. Number theory, in turn, plays a crucial role in the field of data encryption for contemporary computer and internet technology.

The Riemann hypothesis, a key conjecture in this field, posits that the real part of every non-trivial zero is 0.5. If the hypothesis is correct, it implies that all non-trivial zeros lie on the critical line, consisting of complex numbers of the form 0.5 + it, where t is a real number, and i is the imaginary unit. This hypothesis, if proven true, would unravel the mystery surrounding the distribution of prime numbers [7].

3. Methodology

To enable the functionality of hidden variables, an alternative explanation of space-time beyond Minkowski space-time is required. Lorenz's transformation of space-time is effective for the special theory of relativity. In this model, time is perceived to exist from the inception of the first dimension of space (X and T). The second dimensions or planes encompass the X, Y, and T axes. Contemporary science incorporates time embedded in three dimensions of space (X, Y, Z, and T), necessitating two arrows of time directions.

In this novel space-time model, crucial for quantum mechanics, two-time arrows become imperative. One arrow extends from the past to the present, while the second arrow moves from the future to the present. The rationale behind incorporating two-time arrows is rooted in the principles of quantum mechanics. Various quantum phenomena, such as the double-slit experiment, quantum entanglement, and quantum leaps, are intricately linked to space-time; they function as derivatives of it.

For this paper, the successful integration of a hidden variable in quantum mechanics hinges on the adoption of a modified space-time model featuring two arrows of time. In this model, for a single dimension of space, time unfolds in two directions – simultaneously from X1 to X2 and from X2 to X1.

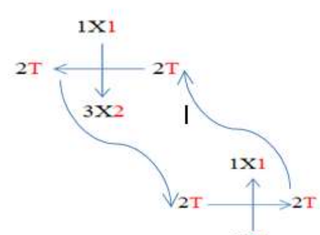

***Fig**.2. A model of one space (X) dimension and two arrows of times (2T) communication.*

In this scenario, time is fixed at the transition of 3 (2T). When progressing from X1 to X2, it follows a sequential pattern, advancing from 1 to 2, traversing 2T to X2, transitioning from 3, and returning to 2T, resulting in a total of 3 transitions. This cyclical process persists, and it never reaches transition 4; it consistently concludes at 3, remaining perpetually locked in 2T. The change in time is zero, as asserted by Lee Smolin and Clelia Verde in their 2021 work, "Quantum Mechanics of the Present". Despite this, in our everyday perception, time appears unidirectional, with a change in time being zero for two complete arrows of time. This phenomenon is replicated when moving from X2 to X1, where the motion from X1 to X2 corresponds simultaneously with returning to X1.

Expanding to the second space dimension, the Y-axis, we incorporate the aforementioned first dimension. As it ascends on the Y-axis, time becomes a factor for the third dimension, which, although invisible, plays a crucial role. In this two-dimensional context, time remains fixed in a total transition of 5, locked in 3T, without reaching a total of 6 transitions.

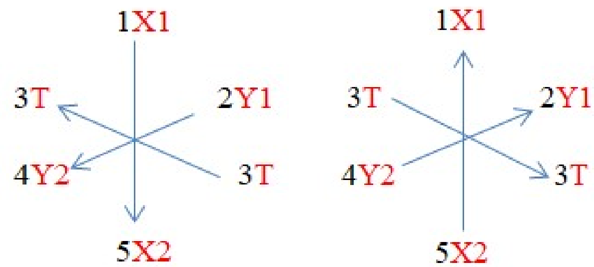

***Fig**. 3. A model of two space (X and Y) dimensions and two arrows of times (3T) communication.*

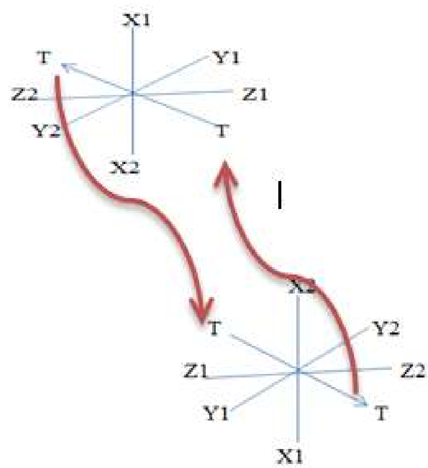

***Fig**.4. A model of new three spaces (X, Y, and Z) and time (T), for two arrows of time. Three dimensions entangled the space-time model. Time, (T) is always aligned with the directions of measurements of X, Y, and Z.*

Time is the only constant that unfolds repeatedly as if we are confined within the perpetual confines of the present moment. The concept of three-dimensional space existing simultaneously has been a subject of contention since Einstein introduced his special theory of relativity. Before his ground breaking work, time was commonly perceived as absolute. However, the interdependence of time and space became evident; one cannot be discussed without the other, and space cannot exist independently of time—they either coexist or were conceived simultaneously.

This space time model also incorporates the phenomenon of quantum entanglement, which involves the spin of entangled particles and their electromagnetic properties. The spin measurement of a particle exclusively interacts with its entangled counterpart within the same dimensional space. Establishing a connection between these particles requires an interrelation in the X, Y, and Z dimensions through time. Consequently, time is posited to have two directions to facilitate this intricate relationship.

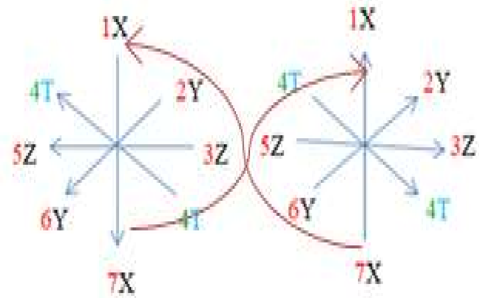

***Fig**.5. Measurement in X direction, spin axis complimentary to each other. This is due to the two arrows or directions of time. This complementarity works for the other dimensions too. Time always aligns with the directions of measurements. And forces the result of the second measurement, to collapse to the opposite result to the first measurement. For this measurement time (4T) aligned to the X dimension (1X: 7X and 7X: 1X). This analogy is for other dimensions measurements too.*

For a single particle, not entangled, measuring its spin along one of the three dimensions yields a result of fifty percent up or down. Subsequent measurements in the same direction produce a consistent hundred percent of the previous value, given the alignment of time in that specific direction. However, altering the spin measurement direction results in a fifty percent probability of the spin being up or down, as time requires a new alignment.

At this juncture, quantum mechanics and entanglement can appear to be locally deterministic, suggesting the presence of hidden local variables. It becomes conceivable to devise a code for their communication across space-time, as demonstrated by the MATLAB Code provided in Appendix A.

4. Main Results (Results from the MATLAB)

The entangled particles, even when separated by great distances, exhibit a fascinating behavior. When one observer measures the spin of an entangled particle in a specific direction and determines whether it is up or down, they can instantly deduce the result for the entangled particle at the remote location—it's as if information travels faster than the speed of light. In the framework of this space-time model, the ability to immediately know the outcome of the entangled particle measurement, through imaginative projection, is a unique feature. The incorporation of a second-time direction, represented by an imaginary time arrow with negative probabilities, enhances the local determinism of quantum entanglement communication.

Traditionally, the zeta function converges and yields a determined real value greater than one. Riemann, through his innovative concept of "Analytic Continuations" and leveraging complex number theory, extends the zeta function beyond its defined domain. This demonstrates the reliance on hidden variables in quantum mechanics and the analytic continuation of the zeta function on complex numbers. In the realm of quantum mechanics, an analytic continuation akin to the Riemann hypothesis exists. The imaginative revelation of information about a far-located entangled particle mirrors the principles of Riemann's complex analysis; in both scenarios, imaginary numbers play a pivotal role in analytic continuation and the theory of local hidden variables in quantum mechanics.

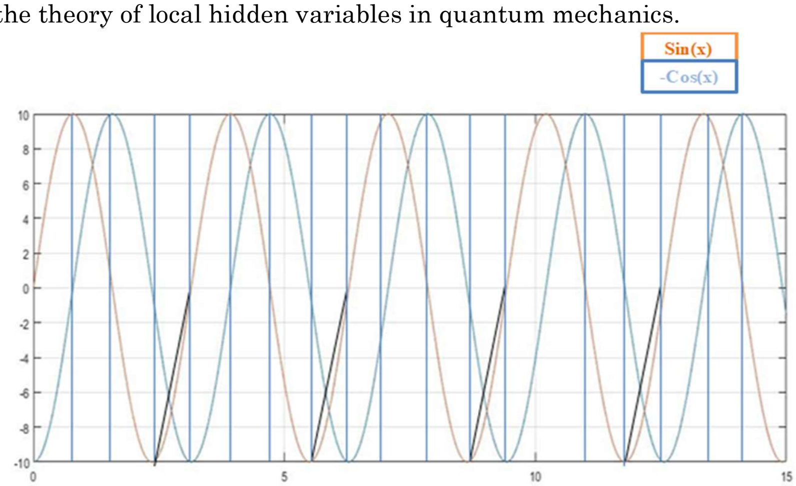

***Fig.6.** Time direction from past to present, is positive probabilities, for example. X (1:5). Black or slope line is a result of positive probabilities of the time direction. Sin(x) and –cos(x) are input functions.*

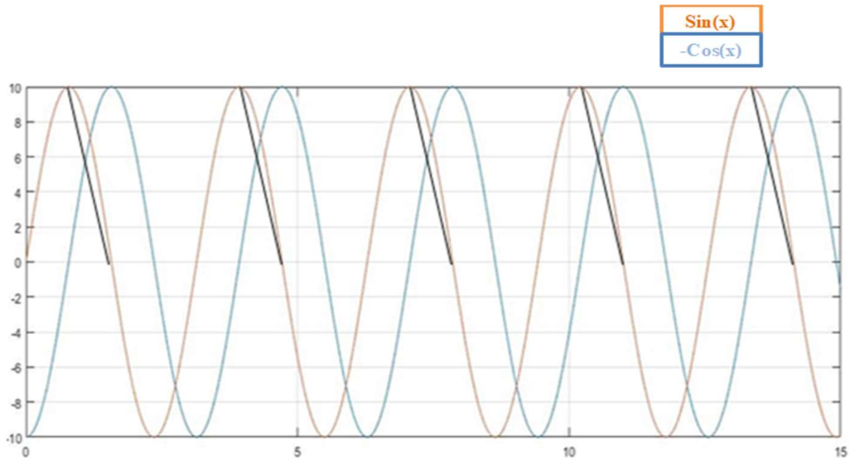

Fig.7. *Time direction is future to present, negative probabilities, example. X (5:1). Black or slope line, output, is a result of negative probabilities of the time direction, for Input trig functions (Sin(x) and –cos(x)).*

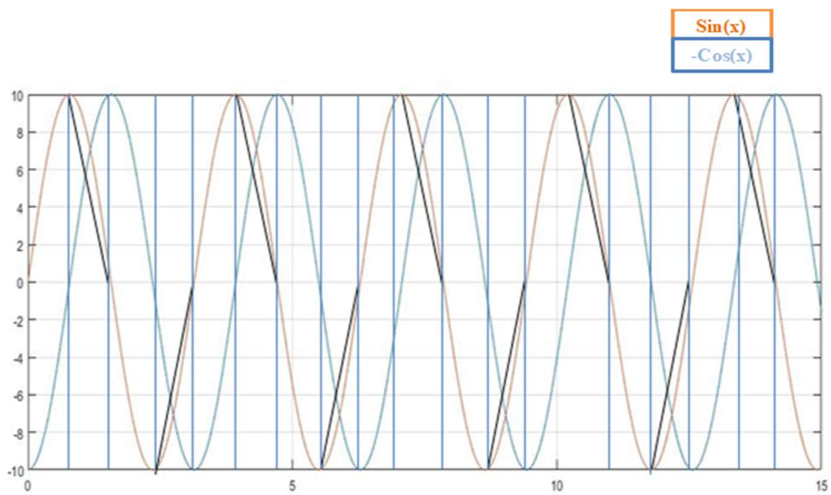

***Fig**. 8. The complete space-time results. Black slope (output) lines inside trig function (input), common values of a negative and a positive probabilistic.*

In Fig. 8, the slope lines (depicted in black font) are situated within the sinusoidal curve and represent outputs for input cosine and sine functions, irrespective of their period and frequency. The output occurs precisely between π/2 and π for negative probabilities in the initial direction. In the subsequent iteration, the output direction shifts to the range between (3π)/2 and 2π, corresponding to positive probabilities.

***Table** 1. Probabilistic results for two arrows of time. Trig function, positive amplitude means, starting point from smaller to higher, increasing value of the vector. Negative amplitude means, a starting point from higher to smaller, decreasing the value of the vector.*

Amplitude (Negative or Positive)	Function (Trigonometric)	Output of New Space-Time Model ($\frac{\pi}{2}$ to π)	Output of New Space-Time Model ($\frac{3\pi}{2}$ to 2π)	Output between (0 to $\frac{\pi}{2}$) and (π to $\frac{3\pi}{2}$)
Positive	Sine	Empty matrix	Negative	Empty matrix
Negative	Cosine	Empty matrix	Negative	Empty matrix
Negative	Sine	Positive	Empty matrix	Empty matrix
Positive	Cosine	Positive	Empty matrix	Empty matrix

.

Table 1 represents the positive amplitude of sinusoidal and negative amplitude of cosine function work in conjunction, sharing a common value. This phenomenon occurs during one-time direction between π/2 to π, and during another time direction between 3π/2 to 2π. Similarly, the negative amplitude of sinusoidal and positive amplitude of cosine function share common values between π/2 to π and during another time direction between 3π/2 to 2π. The intervals 0 to π/2 and π to 3π/2 constitute an empty matrix for the entire time direction (both positive and negative probabilities), resembling the Riemann strip, with exceptions at π/4, the critical line, and the location of non-trivial zeros.

The value of Acos (2πft+π/4) tends towards zero, either positively or negatively, depending on the direction of time and amplitude. When the cosine angles are shifted to π/4, the cosine function evaluates to zero. Similarly, the value of Asin(2πft+π/4) approaches the amplitude (slope A), reaching 0 in both positive and negative directions based on the time's orientation and the amplitude's sign. For example, it is positive as time progresses from the right towards π/4 and negative as time approaches π/4 from the negative direction.

In the intervals 0 to 1, 0 to π/2, and π to 3π/2, as illustrated in Fig. 9 between Y (A) and X (C), an empty matrix is formed with no values, except for the non-trivial zeros precisely located at π/4, possessing a real value of 0.5. This vacant matrix signifies the region where quantum mechanics transitions from deterministic to probabilistic, a conclusion drawn by Bell. Addressing this transition by correctly incorporating time directions and input variables results in a deterministic output, eliminating probabilistic aspects for the round trip of time. In this context, quantum mechanics involves hidden local variables.

Slope B, derived from Bell inequalities, only attains equality at that particular moment. It also corresponds to the Riemann hypothesis regarding the locations of non-trivial zeros. Other values within the range of 0 to 45^0 to 90^0 fall within probabilistic regions. Slope B functions as the pole of a quantum hidden variable, demarcating the boundary where chaos and deterministic reality diverge. Its value is 0.5 in the context of the Riemann hypothesis.

$$Sin^2(90) = sin^2\left(\frac{90}{2}\right) + sin^2\left(\frac{90}{2}\right)$$

$$1 = 0.5 + 0.5$$

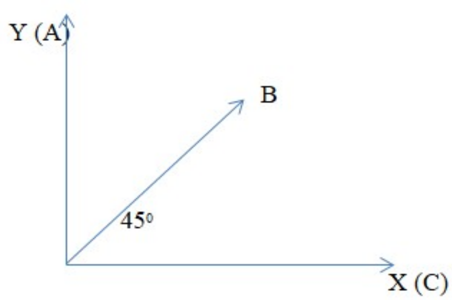

***Fig** .9. Quantum Mechanics' hidden variable and Riemann trivial zero locations, at slope B.*

Heisenberg's uncertainty principle dictates that the wave and particle properties of a photon coexist. Whether it's light or an electron passing through a double slit, it assumes a property linked to the probabilistic, interfering wave arising from the intricacies of space-time. In situations where the starting orientation of a photon is unknown, represented by a value adhering to Riemann's conjecture (a value between 0 and 1, excluding a real value of X at 0.5), a peculiar phenomenon occurs. This anomaly stems from a single photon seemingly traversing backward in time, creating self-interference and manifesting as an interference wave observable to the naked eye—a phenomenon Riemann termed the critical strip.

Upon introducing measuring equipment into the equation and scrutinizing each step of a photon's trajectory, the particle-like nature of the photon becomes apparent. This occurs within the region encompassing the critical line, with Real(s) at X equal to 0.5. Remarkably, these predictions align accurately with observed values. Addressing a crucial aspect overlooked by Bell's theorem, quantum mechanics measurements along the X, Y, or Z orientations of spin invariably maintain their orthogonality.

Fourier series

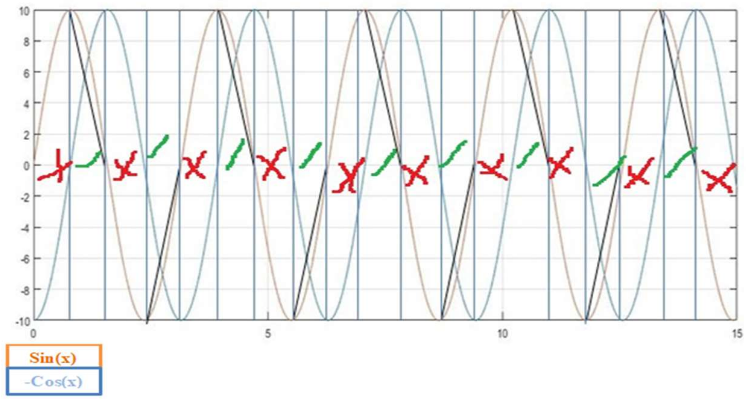

***Fig**.10. The red, cross sign, is an empty matrix, critical strip, and critical line location. Green tic is valued out of the region of 0 <0.5< 1, 0 to$\frac{\pi}{2}$, π to $\frac{3\pi}{2}$(green tic, out of the critical strip and critical line of Riemann's hypothesis, it is a region between $\frac{\pi}{2}$ to π, $\frac{3\pi}{2}$ to 2π , the other time direction result).*

The unambiguous result of the above process, whether employing a sine or cosine input into the space-time model, yields Figure 10. This complete arrow of time exhibits a period of π, as the term -π functions as a global phase in the quantum states (see J. S. Bell, On the Einstein-Podolsky-Rosen Paradox, 1964).

4.1 Trivial Zeros

The MATLAB code computes trivial zeros across the entire time span. The primary arrow of time generates a negative output, whereas the secondary arrow of time produces a positive result. All trivial zeros are located on negative even numbers. The MATLAB code computes trivial zeros over the entire time span. The conventional arrow of time results in a negative output, while the second arrow of time leads to a positive outcome. All trivial zeros are positioned on negative even numbers.

$$. f(x) = -x for \frac{\pi}{2} < x < 0 = x - \pi \, for \frac{\pi}{2} < x < \pi \tag{1}$$

Equations show the results of positive and negative probabilities, the complete time direction of space-time. This is the output in Fig.6, Fig. 7, and Fig. 8 as black slope lines inside trig functions.

The Fourier series values of the above equations give:

$$a_{2n} = 0$$

All even values of a_n zero for complete time direction.

$$b_{2n} = 0$$

All even values of b_n zero for complete time direction.

$$\xi(s) = \sum_{n=1}^{\infty} \frac{1}{n^s} \tag{2}$$

In equation 2, s stands for the complex number, real value different from one. At the real value one, the function is undefined. The real (s) of one, is the pole of the zeta function. The output of this space-time at value one, or $\frac{\pi}{2}$ the result is undefined. Its value is the amplitude of the trig function. Riemann zeta functions after analytic continuation, have value zero for all s negative even integer numbers, called trivial zeros.

All even values, denoted as b_{2n} and a_{2n} for natural numbers n, are zero throughout the entire time direction. The reverse function, G(x) = -f(x), shares the same Fourier series representation as the original function, except with a negative sign. The zeros of this reverse function also occur at negative even values, similar to the ones described above.

4.2 Non-Trivial Zeros

At the point where X equals the real value 0.5 or within the harmonic series, shifting the function's origin or y-axis to X equals (π)/4 results in all values becoming zero. In other words, at X equals (π)/4, the function is odd, signifying that a_0 and a_n are zero. The same holds true for b_n in the case of two arrows of time, but they hold a value for a single arrow of time. For the other arrow, the value is the opposite sign or a modulation of it.

The location of Riemann's non-trivial zeros is depicted as 0.5 + i (something) because it considers only one direction of time. In this scenario, the completion of two arrows of time nullifies each other's imaginary values. The exclusive consideration of one direction of time precisely results in Riemann's non-trivial zeros at 0.5 + (something) i.

5. Summary, Discussion, and Conclusion

The connection between quantum mechanics and Riemann critical lines becomes evident from the correlation with hidden variables and non-trivial zero values. Quantum mechanics exhibits a fixed value of 50% for small angles, attributed to the orthogonality of entangled pairs. Notably, this phenomenon renders quantum mechanics ineffective within the 0° to 90° range, defined as the critical strip of the Riemann hypothesis.

In this critical strip, the cancellation of probabilities occurs between one-time direction and the other, resembling the probabilistic nature of quantum mechanics. The only remaining angles, specifically 45° or the critical lines of the Riemann hypothesis, align with a 50% value in quantum mechanics. This alignment corresponds to Riemann's hypothesis regarding the location of non-trivial zeros, establishing a unique connection between the two domains.

Light is believed to behave as a wave; when passed through a double slit, it exhibits wavelike characteristics. The trough of one wave meeting the crest of another wave leads to wave cancellation, while crest aligning with the crest results in a higher amplitude. This phenomenon is known as constructive and destructive interference waves, and it is not confined to light; it also occurs with larger particles such as ocean waves and sound waves.

The question at hand is whether firing one photon or electron at a time leads to the buildup of an interference wave. It's as if an electron or photon, when fired individually, somehow travels back in time and interferes with itself. This intriguing phenomenon prompted scientists to conduct a detector experiment, often referred to as the "which way" or "which slit" experiment. The results, in turn, were equally astonishing.

In this experiment, when firing particles individually, the electron or photon ceases to exhibit wave-like behavior and instead behaves as a particle. Surprisingly, fifty percent of the particles go through one slit, and the remaining fifty percent go through the other slit, without any interference occurring.

To interpret this experiment without a detector, the behavior of electrons or photons is probabilistic or random. However, with the introduction of a detector, their behavior becomes deterministic and classical, devoid of probabilistic aspects. One crucial aspect that often goes unnoticed in this analysis is the role of time. While time typically progresses forward for larger entities, in the realm of small particles governed by Quantum Mechanics, time exhibits symmetry between its backward and forward movements.

For an observer without specialized tools witnessing a double-slit experiment, the interference pattern of waves seems to emerge due to the intricate interplay of time's back-and-forth movement, creating an illusion. Yet, when a detector is employed, interference ceases to occur. Instead, every minute movement or trajectory of electrons is meticulously recorded. Under these conditions, interference becomes impossible to manifest.

In this deterministic scenario resembling classical physics, reminiscent of larger objects, fifty percent of photons pass through one slit, and the remaining fifty percent through the other slit. This classical behavior, devoid of probabilistic elements, leads to a 50% outcome. It's akin to the cumulative result of all probabilities, comparable to the infinite tosses of a coin yielding a 50% occurrence of heads and tails—an analogy evoking Riemann's critical line.

Quantum Tunneling stands as one of the enigmas within quantum mechanics. While light owes its existence to this phenomenon, comprehending the underlying philosophy remains a formidable challenge. Contemporary technologies face limitations, with the production of smaller transistors becoming increasingly arduous, primarily due to the effects of quantum tunneling. Electrons, in such scenarios, elude control.

As the barriers decrease in width, electrons traverse from one side to the other, defying classical physics. Placing electrons within a barrier-enclosed space renders them invisible on the opposite side in classical physics, yet in quantum mechanics, such occurrences are routine. Here, the role of space-time is pivotal. The symmetry of time at the present moment results in the interference of small particles, propelling them to leap across the barrier. This phenomenon unfolds within a quantized space-time, manifesting in a miniature world.

Notably, the phenomenon of quantum tunneling occurs exclusively when the barrier is exceptionally narrow. The efficiency of tunneling diminishes as particles progress from atoms to molecules and eventually to larger particles.

The energy levels of electrons within an atom, contrary to common belief, exhibit a similarity to the distribution of prime numbers. Prime numbers serve as the fundamental building blocks of numerical sequences, akin to electrons, protons, and atoms acting as the foundational components of particles. In classical physics, energy levels follow a smooth and continuous pattern, whereas in quantum mechanics, energy manifests in discrete steps, resembling a ladder with no intermediary energy levels. This ladder phenomenon, akin to the distribution of prime numbers according to the Riemann hypothesis, is a characteristic of quantum mechanics. The quantization of space-time is the underlying factor contributing to the formation of such energy ladders. Despite the apparent chaos in the distribution of prime numbers, they are, as hypothesized by Riemann, inherently deterministic.

The logic of a double-slit experiment involves firing electrons one at a time and placing a detector. Fifty percent go through one slit, and the remaining fifty percent go through the other slit. The same principle applies to quantum entanglement, where there is a fifty percent chance of spin up and a fifty percent chance of spin down when measured in the same alignment. This behavior arises from a pure circle or single wave.

However, the accumulation of many waves results in a deterministic outcome for a seemingly random signal. We can manipulate quantum energy at different steps with the aid of various harmonics. Primes can be likened to the random outcomes obtained by adding all harmonics, ultimately providing a perfect deterministic result when incorporating non-trivial zeros into the hypothesis.

You might wonder why quantum entanglement consistently yields a 50% result in the latter comparison. The explanation lies in the fact that the one-time direction of the random signal negates the other side of the random signal. Consequently, in the critical strip following analytic continuation, you will consistently discover the same value—a symmetry of s=0.5 in the real domain.

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Compliance with Ethical Standards

Conflicts of Interest: Authors declared that they have no conflict of interest.

Human Participants: The conducted research follows the ethical standards and the authors ensured that they have not conducted any studies with human participants or animals.

References

[1] N. Einstein, Rosen, and B. Podolsky, "Phys. Rev, vol. 47, pp. 777, 1935; see also N. Bohr, Ibid. vol. 48, pp. 696 1935, W. H. Furry, Ibid. vol. 49, pp. 393 and 476, 1936, and D. R. Inglis, "Rev. Mod. Phys. Vol. 33, pp. 1, 1961.
[2] Bohm, "Phys. Rev. vol. 85, pp. 166 and 180, 1952.
[3] J. S. Bell, “On the einstein podolsky rosen paradox”, Physics Physique Fizika, Vol. 1, no.3, pp.195, 1964.
[4] R. V. Ramos, and F. V. Mendes, “Riemannian quantum circuit”, Physics Letters A, Vol. 378, no.20, pp.1346-1349, 2014.
[5] D. C. David Cassidy, “Uncertainty: the life and science of Werner Heisenberg”, 1994.
[6] A. Einstein, “On the electrodynamics of moving bodies”, 1905.
[7] E. Whittaker, (November 1, 1955, Franklin, Richard Langdon 1968. Imaginary unit (Beurling, Arne (1955).
[8] D. I. Kaiser, “Tackling Loopholes in Experimental Tests of Bell's Inequality”, arXiv preprint arXiv:2011.09296, 2020.
[9] Alain Aspect, "Bell’s theorem: The Naive View of an Experimentalist-Centre University of d’Orsay," 1982.
[10] A. Aspect, “Bell’s theorem: the naive view of an experimentalist”, pp. 119-153, Na, 2002.
[11] A. M. Odlyzko, “Correspondence about the origins of the Hilbert-Polya conjecture”, 1910.
[12] R. P. Brent, D. J. Platt, and Trudgian, “A harmonic sum over nontrivial zeros of the Riemann zeta-function”, Bulletin of the Australian Mathematical Society, Vol. 104, no.1, pp.59-65, 2021.
[13] S. Hossenfelder, and T. Palmer, “Rethinking superdeterminism”, Frontiers in Physics, Vol. 8, pp.139, 2020.
[14] J. R. Hance, S. Hossenfelder, and T. N. Palmer, “Supermeasured: Violating Bell-Statistical Independence without violating physical statistical independence”, Foundations of Physics, Vol. 52, no.4, pp.81, 2022.
[15] L. Smolin, “Einstein's unfinished revolution: The search for what lies beyond the quantum”, Penguin, 2019.
[16] L. Smolin, and C. Verde, “The quantum mechanics of the present”, arXiv preprint arXiv:2104.09945, 2021.
[17] R. Penrose, “On the gravitization of quantum mechanics 1: Quantum state reduction”, Foundations of Physics, Vol. 44, pp.557-575, 2014.

[18] S. Goldberg, “Max Planck’s philosophy of nature and his elaboration of the special theory of relativity”, Historical Studies in the Physical Sciences, Vol. 7, pp.125-160, 1976.

Appendix A

```
tic
clearall

%%% Some Option of Trig function
%A=10*sin((3.14)*255*(1:1:7));%%%%%Starts from small value to higher value
A=-10*sin((3.14)*255*(1:1:7));%%%%%Starts from high value to small value
%A=cos((((pi*2)-(pi/4))*350*(1:1/350:3.5));%%% Non-trivial zero for real% number
%A=sin((((pi*2)+(pi/4))*450*(1:1/450:3.5));%% Non trivial for imaginary values for one time direction
%A= sin(pi*2*250*(1:1:7))-1*cos(pi*2*250*(1:1:7));
%A= -10*cos(3.1415923565*2*258*(1:1:7));%%%%%%%%Starts from high value to small value
pp1=input('inter the value of point 1')
pp2=input('enter the value of point 2')
x1=pp2*A;% Magnitude X - point one for the first arrow of time
x2=pp1*A; % Magnitude X - point two  for the first arrow of time
y1=pp2*A;% Magnitude Y - point one for the first arrow of time
y2=pp1*A;% Magnitude Y - point two for the first arrow of time
z1=pp2*A; % Magnitude Y - point one for the first arrow of time
z2=pp1*A;% Magnitude Z - point two for the first arrow of time
 t1=pp2*A;% Magnitude T - point one not Neseccarly this value
 t2=pp2*A;% Magnitude T - point one not Neseccarly this value
if x2==pp1*A
X1=x2;% way of making spin up and down through time
 t1=pp2*A;
 t2=pp2*A;
end
if y2==pp2*A
    Y1=y2;% way of making spin up and down through time
     t1=pp1*A;
 t2=pp2*A;
end
if z2==pp2*A
    Z1=z2;% way of making spin up and down through time
     t1=pp2*A;
 t2=pp1*A;
end
if t1==pp2*A
    t2=pp2*A;% way of making spin up and down through time
end
          T=t1;
T=t2;
X1=pp1*A;% Magnitude X - point one for the second arrow of time
X2=pp2*A;% Magnitude X - point two for the second arrow of time
Y1=pp1*A;% Magnitude X - point one for the second arrow of time
Y2=pp2*A;%Magnitude X - point two for the second arrow of time
Z1=pp1*A;% Magnitude X - point one for the second arrow of time
Z2=pp2*A;%Magnitude X - point two for the second arrow of time
 t11=pp2*A;% Magnitude T - point one not Necessary this value
 t22=pp2*A;% Magnitude T - point one not Necessary this value
if X2==pp2*A
x1=X2;% way of making spin up and down through time
 t11=pp2*A;
 t22=pp2*A;
end
if Y2==pp2*A
    y1=Y2;% way of making spin up and down through time
     t11=pp2*A;
 t22=pp2*A;
end
if Z2==pp2*A
    z1=Z2;% way of making spin up and down through time
     t11=pp2*A;
 t22=pp2*A;
end
if t11==pp2*A
    t22=pp2*A;
```

```
end
 T=t11;T=t22;fr1=1;fr11=1;fr=1;fr12=1;fr2=1;fra=1;tt=(T:0.01:T);
fr1=1;fr11=1;fr=1;fr12=1;fr2=1;fra=1;
l=10;% incase using exponential function known P1
P1=20*exp(l);
P=10;%incase using constant value P
 L=1;% this is were the iteration start
m(fra)=getframe; %Movie play
fra=fra+100;
while(L<5)
figure(2) %%%For time forward
subplot(2,1,1)
plot3((x1*P:0.1:x2*P)*-P,(y1*P:0.1:y2*P)*-P,(z1*P:0.1:z2*P)*-P,'.','MarkerSize',50)
xlabel('xx'),ylabel('yy'),zlabel('zz'),title('time(fourth dimension)'),
grid
figure(2)
subplot(2,1,2)
plot3((x1*P:0.01:X2*P)*P,(y1*P:0.01:Y2*P)*P,(z1*P:0.01:Z2*P)*P,'y.','MarkerSize',50)
xlabel('x'),ylabel('y'),zlabel('z'),title('known 4D world'),
grid
figure(1)
subplot(2,1,1)
plot(A,'R','MarkerSize',5)
xlabel('x'),ylabel('y'),ylabel('Z'),title('Amplitude-time representation of known random signal
f(t)=(45*sin(3.14*2*20*(1:0.01:7))+20*sin(3.14*29*2*(1:0.01:7))+5*sin(3.14*2*45*(1:0.01:7))+9*sin(3.14*2*50*(1:0.01:7)))'),grid
grid
figure(1)
subplot(2,1,2)
  plot3((-x1*P:0.1:-x2*P)*P1,(-y1*P:0.1:-y2*P)*P1,(-z1*P:0.1:-
z2*P)*P1,'b.','MarkerSize',3)%,hold,plot3((x1*P:0.001:x2*P)*P,(y1*P:0.001:y2*P)*P,(z1*P:0.001:z2*P)*P,'y.','MarkerSize',50)%,hol
d,plot3((z22:x1)*t,(x22:y1)*t,(y22:z1)*t,'r.','MarkerSize',50)
xlabel('X'),ylabel('Y'),zlabel('Z'),title('Amplitude-time-frequency zoom out of random signal
F(t)=(45*sin(3.14*2*20*(1:0.01:7))+20*sin(3.14*29*2*(1:0.01:7))+5*sin(3.14*2*45*(1:0.01:7))+9*sin(3.14*2*50*(1:0.01:7)))')
grid
%yy=(x1*P:1:x2*P)*P,(y1*P:1:y2*P)*P,(z1*P:1:z2*P)*P
pp=(-x1*P:1:-x2*P)*P1,(-y1*P:1:-y2*P)*P1,(-z1*P:1:-z2*P)*P1%% Value in number
figure(3)
subplot(2,1,1)

plot3((x2*P:0.01:X1*P)*P,(y2*P:0.01:Y1*P)*P,(z2*P:0.01:Z1*P)*P,'.','MarkerSize',50)%,hold,plot3((X1*P:0.01:x2*P)*P,(Y1*P:0.0
1:y2*P)*P,(Z1*P:0.01:z2*P)*P,'Y.','MarkerSize',50)
%plot3((z22:x1)*t,(x22:y1)*t,(y22:z1)*t,'g.','MarkerSize',50),hold,plot3((x11:z2)*t,(y11:x2)*t,(z11:y2)*t,'g.','MarkerSize',50)
%plot3((x11:z2)*t,(y11:x2)*t,(z11:y2)*t,'g.','MarkerSize',50),hold,plot3((z22:x1)*t,(x22:y1)*t,(y22:z1)*t,'g.','MarkerSize',50)
xlabel('x'),ylabel('y'),zlabel('z'),grid
drawnow
m(fr)=getframe;
fr=fr+1;
figure(3)
subplot(2,1,2)

plot3((X1*P:0.001:x2*P)*P,(Y1*P:0.001:y2*P)*P,(Z1*P:0.001:z2*P)*P,(x2*P:0.01:X1*P)*P1,(y2*P:0.01:Y1*P)*P1,(z2*P:0.01:Z1*
P)*P1,'g.','MarkerSize',150)%,hold,plot3((x1*P:0.01:X2*P)*P,(y1*P:0.01:Y2*P)*P,(z1*P:0.01:Z2*P)*P,'y.','MarkerSize',50)%,hold,p
lot3((x11:x22)*t,(y11:y22)*t,(z11:z22)*t,'g.','MarkerSize',50)
xlabel('x'),ylabel('y'),zlabel('z'),grid
drawnow
m(fr1)=getframe;
    fr1=fr1+1;
figure(4)
subplot(2,1,1)%For time reverse
plot3((x2*P:x1*P)*P,(y2*P:y1*P)*P,(z2*P:z1*P)*P,(X1*P:X2*P)*P1,(Y1*P:Y2*P)*P1,(Z1*P:Z2*P)*P1,'r.','MarkerSize',50)%,hold,
plot3((X2*P:0.001:X1*P)*P,(Y2*P:00.001:Y1*P)*P,(Z2*P:0.001:Z1*P)*P,'r.','MarkerSize',150),
%,hold,plot3((x11:z2)*t,(y11:x2)*t,(z11:y2)*t,'r.','MarkerSize',50)
xlabel('xx'),ylabel('yy'),zlabel('zz'),
title('Time reverse For Three Dimension')
grid
drawnow
m(fr12)=getframe;
    fr12=fr12+1;
figure(4)% For time forward
subplot(2,1,2)
```

```
  plot3((x2*P:x1*P)*-P,(y2*P:y1*P)*-P,(z2*P:z1*P)*-P,(X1*P:X2*P)*-P1,(Y1*P:Y2*P)*-P1,(Z1*P:Z2*P)*-
P1,'r.','MarkerSize',50)%,hold,plot3((X2*P:0.001:X1*P)*P,(Y2*P:00.001:Y1*P)*P,(Z2*P:0.001:Z1*P)*P,'r.','MarkerSize',150),
%,hold,plot3((x11:z2)*t,(y11:x2)*t,(z11:y2)*t,'r.','MarkerSize',50)
title('Time forward For Three Dimension')
grid
drawnow
m(fr2)=getframe;
  fr2=fr2+1;
  fr12+fr12+1;
  fr11=fr11+1;
L=L+1;
end
toc
```