IOSR Journal of Applied Physics (IOSR-JAP)
e-ISSN: 2278-4861.Volume 13, Issue 6 Ser. I (Nov. – Dec. 2021), PP 16-36
www.iosrjournals.org

What If Complementarity and Superposition Are Only Imaginations and Einstein's Hidden Variables Are Nothing but Truth

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[Abstract]

Both photon and electron have wave and particle properties. In Double Slit Interference experiment, particle detector can be used to influence the phase angles of particle waves such that the coherency is disturbed and the interference patterns are diminished or even totally disappeared. However, the interruption of the interference patterns cannot to be used to prove the non-existence of wave property, or even to prove that wave and particle properties cannot coexist at the same time under observation. Therefore, "Complementarity Principle" is not true. In addition, both photon and electron have predetermined quantum energy states (Hidden Variables). In electron spin measurements, energy can be added to electrons through electron polarization process. Subject to the threshold energy, electrons can move to the new quantum energy states (Field Dependent Hidden Variables) either by staying at the same spin mode or flipping of to the opposite spin mode. On the other hand, in photon polarization measurements, energy can be removed from photons through photon polarization process. Subject to the threshold energy, photons can either enter into the new quantum energy states (Field Dependent Hidden Variables) by maintaining the same spin mode or totally blocked by the energy barrier. Even more, through further transformations, both photons and electrons can be transferred to normalized quantum energy states (Normalized Field Dependent Hidden Variables). In Quantum Entanglement experiments, both entangled photons and electrons have the same Hidden Variables except in opposite spin directions. Under the same polarization transformation processes (measurements), they both gain or lose the same energies as passing through the same threshold energy barriers and have the same Field Dependent Hidden Variables except in the opposite spin directions. Therefore, they are always entangled no matter how far the distance and how fast the time are. Bell's Inequality is based on Set Theory and can only be applied on the same sample space. Therefore, in photon polarization experiments, Bell's Inequality applying on the mixed sample spaces cannot be used to prove if Hidden Variables exist or not. On the other hand, in Quantum Entanglement experiments, with the right experimental data, Bell's Inequality applying on the same sample space does approve the existence of the Hidden Variables. As a result, both electron and photon do carry predetermined Hidden Variables, and Schrödinger's Cat cannot be both alive and dead at the same time. Therefore, "Quantum Superposition" cannot be true. Also, there is no mystery, no surprise and certainly no "Spooky" behavior. Einstein is correct after all.

[Keywords]

Quantum Mechanics, Single Slit Diffraction, Double Slit Interference, Complementarity, Superposition, Quantum Entanglement, EPR Paradox, Hidden Variables, Bell's Inequality, Schrödinger's Cat, Electron Spin, Photon Spin, De Broglie Matter Wave, Wu's Pairs, Yangton and Yington Theory

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Date of Submission: 04-11-2021 Date of Acceptance: 18-11-2021

I. Introduction

In quantum physics, two phenomena "Complementarity" [1] and "Superposition" [2] are most mysterious and have caused a lot of confusions. According to De Broglie Matter Wave Theory [3], electron can have both wave and particle properties known as Wave Particle Duality [4]. However, when under observation, such as Double Slit Experiment [5], only one of the two properties can reveal. This phenomenon is known as "Complementarity". In addition, complying with Schrödinger's wave equations, for each quantum energy state, electron can possess both spin up and spin down angular momentums at the same time. This phenomenon is known as "Superposition". Again, upon observation, only one, either spin up or spin down, can be revealed, such as that illustrated in Schrödinger's Cat [6] thought experiment. Furthermore, in Quantum Entanglement [7] experiment, once the spin of one of the entangled electrons is observed, the other one with opposite spin can always be found no matter the time and location. Einstein called this a "Spooky" behavior and challenged it with EPR Paradox [8]. Not until later, Einstein's "Hidden Variables" theory [9] was proven wrong by "Bell's Inequality" theory [10]. Since then, both Complementarity and Superposition are generally accepted by science community. However, the incompletion of the experiments has been often challenged in the pass decades. To solve this problem, a detailed analysis is studied and a sound conclusion is proposed in this review paper.

II. Diffraction and Interference

Interference is caused by superimposing two waves together. Diffraction on the other hand is caused by the interference of a number of waves emitted from a continuous source points in two or three dimensions. Huygens' principle [11] lets us treat wave propagation by considering every point on a wave front to be a secondary source of spherical wavelets. These wavelets propagate outward with the speed of the wave. The wavelets emitted from all points on the wave front interfere with each other to produce the traveling wave. Huygens' Principle also holds for electromagnetic waves and electron particle waves.

In contrast, based on Yangton and Yington Theory, waves can be generated by a spinning polarized particle along its moving path. In other words, all spinning polarized particles such as photon and electron shall have both particle and wave properties known as Wave Particle Duality. In study of the propagation of photon and electron, the wave front is represented by a group of coherent (in phase) photons and electrons. When passing through a number of particles or a narrow slit, photons and electrons are scattered away as the radiations from a group of point sources.

III. Single Slit Diffraction

When light passes through a single slit whose width is on the order of the wavelength of the light, we can observe a single slit diffraction pattern on a screen that is at a distance away from the slit. The intensity is a function of angle. Conventionally, Huygens' principle tells us that each part of the slit can be thought of as an emitter of waves. All these waves interfere to produce the diffraction pattern. Where crest meets crest we have constructive interference and where crest meets trough we have destructive interference (Fig. 1).

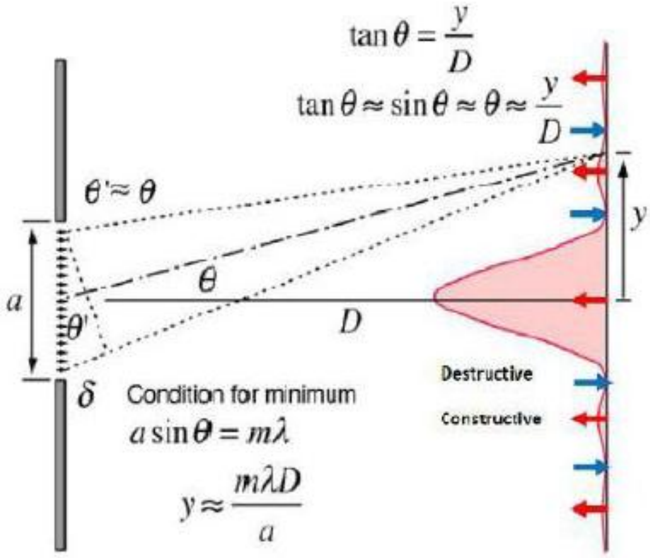


Fig. 1 The mechanism of single slit diffraction generated by particle wave.

In contrast, based on Yangton and Yington Theory, all particles including non-spinning and spinning particles emitted from a single slit will form a normal distribution projection image (Fig. 2). However, a wave produced by spinning polarized particles such as photons and electrons, passes through the single slit, a similar diffraction pattern as Fig. 1 can be generated except by attractive and repulsive interferences instead of constructive and destructive interferences.

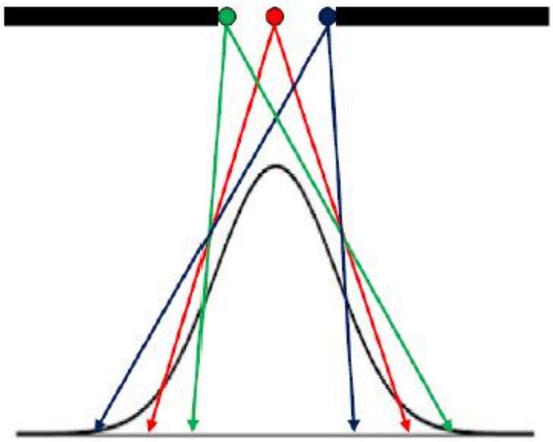


Fig. 2 The normal distribution image of single slit generated by non-spinning particle emission (without diffraction)

IV. Double Slit Interference and Complementarity Principle

In modern physics, the Double Slit Experiment is a demonstration that light and matter can display characteristics of both classically defined waves and particles. Moreover, it displays the fundamentally probabilistic nature of quantum mechanical phenomena. This type of experiment was first performed by Thomas Young in 1801, as a demonstration of the wave behavior of light.

In the basic version of this experiment, a coherent light source, such as a laser beam, illuminates a plate pierced with two parallel slits, and the light passing through the slits produces an interference pattern on a screen behind the plate (Fig. 3). Interference is considered "Wave Nature of Light", and it would not be expected if light consisted of classical particles. (In fact, interference would not be expected neither if the two incident lights are incoherent).

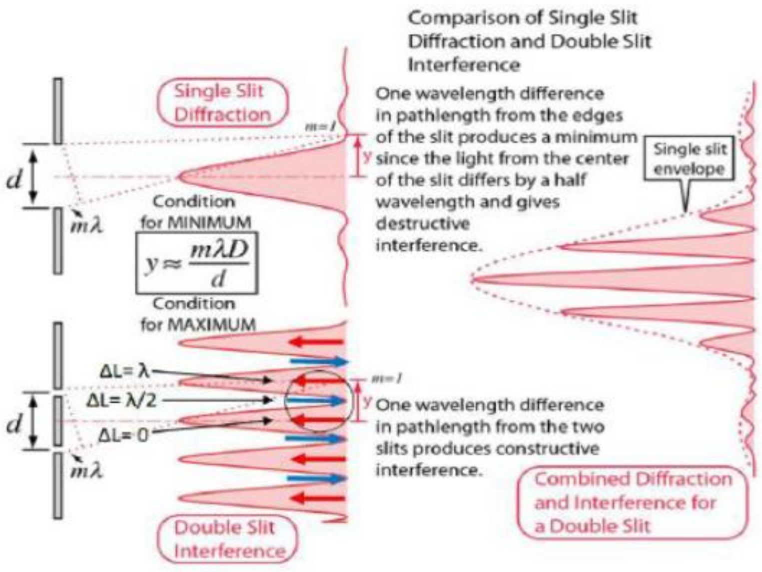


Fig. 3 Single Slit Diffraction and Double Slit Interference.

Other versions of the experiment that include detectors at the slits find that each detected photon passes through one slit (as would a classical particle), and not through both slits (as would a wave) [12]. As a result, two single slit diffraction patterns can be found instead of interference (wave nature). This which-way experiment illustrates the "Complementarity Principle" that photons can behave as either particles or waves, but cannot be observed as both at the same time.

In 1961, Claus Jönsson of the University of Tübingen performed the experiment with electron beams [13]. In 1974, the Italian physicists Pier Giorgio Merli, Gian Franco Missiroli, and Giulio Pozzi repeated the experiment using single electrons and biprism (instead of slits). Sending particles such as electrons through a double-slit apparatus one at a time results in single particles appearing on the screen, however, an interference pattern emerges when these particles are allowed to build up one by one (Fig. 4) [14]. This demonstrates the “Wave Particle Duality” which states that all matter exhibits both wave and particle properties: the particle is measured as a single pulse at a single position, while the wave describes the probability of absorbing the particle at a specific place on the screen [15].

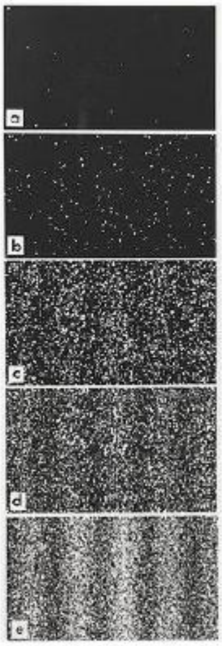


Fig. 4 Step by step build up pattern of electron Double Slit Interference.

This phenomenon has been shown to occur with photons, electrons, atoms and even some molecules, including buckyballs. So experiments with electrons add confirmatory evidence to the view that electrons, protons, neutrons, and even larger entities that are ordinarily called particles nevertheless have their own wave nature and even a wavelength (related to their momentum).

The Double Slit Experiment (and its variations) has become a classic thought experiment, for its clarity in expressing the central puzzles of quantum mechanics. Because it demonstrates the fundamental limitation of the ability of the observer to predict experimental results, Richard Feynman called it "A phenomenon which is impossible to explain in any classical way, and which has in it the heart of quantum mechanics. In reality, it contains the only mystery of quantum mechanics"[16].

An experiment performed in 1987 [17] produced results that demonstrated that information could be obtained regarding which path a particle had taken without destroying the interference altogether. This showed the effect of measurements that disturbed the particles in transit to a lesser degree and thereby influenced the interference pattern only to a comparable extent. In other words, if one does not insist that the method used to determine which slit each photon passes through be completely reliable, one can still detect a (degraded) interference pattern [18].

V. Mechanisms of Interferences

When two waves (same kind) come together, constructive interference (crest to crest) and destructive interference (crest to trough) can be formed. However, for particle waves such as photon and electron, what does the destructive interference mean? Does it mean that particles disappeared? Or just the electromagnetic fields and angular momentums diminished? Because most detectors placed at the screen can only detect particle’s existence as shown in single electron Double Slit Experiment, when there is no signal response, or in other words, when a destructive interference is detected, it simply means that there is no particle appeared at that location. Question is where those particles go? Destroyed? Converted to energy? Or depleted? Based on the “Law of Conservation of Mass” that particles cannot be destroyed, and also the “Conversion between Mass and

Energy" which can only happen in Big Bang and nuclear reaction, the only possible answer is that particles are depleted in the region of destructive interference. Therefore, attraction and repulsion are proposed as the mechanisms for the interferences of particles instead of construction and destruction (Fig. 5) [19].

According to Yangton and Yington Theory, when two photons come together side by side, they can attract to each other if they are in phase (electrical dipoles in the same direction), or otherwise they repulse to each other if they are out of phase (electrical dipoles in opposite directions) (Fig. 5). Similar mechanism can be found in electron particle waves. Because electron can be considered as a small magnet, when two electrons come together side by side, they can attract to each other if they are in phase (north to north), or otherwise they repulse to each other if they are out of phase (north to south) (Fig. 5). In addition, for single electron Double Slit Experiment, subject to the traveling time, direction and distance of each electron, both attractive and repulsive interferences can also happen between the two electrons each from different slits. Furthermore, it explains Richard Feynman's mystery. The possibility to find the particles landed on certain area of the screen is not due to the probability nature of quantum mechanics but the contribution of attractive and repulsive interferences.

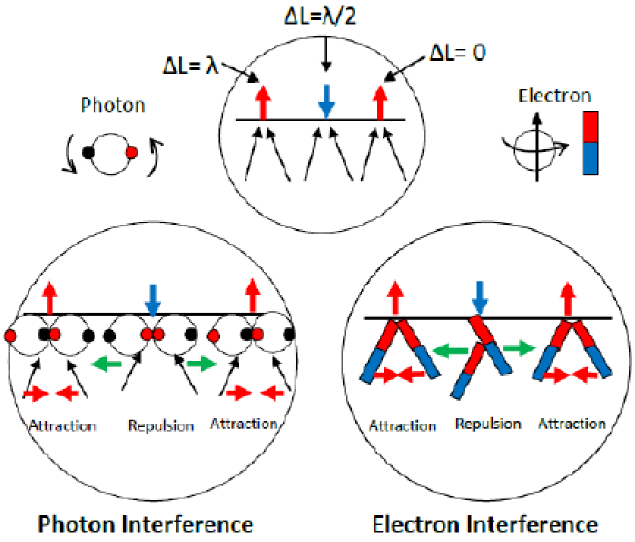


Fig. 5 Mechanisms of photon interference and electron interference.

Interruption of Interference

In Double Slit Experiment, interference occurs only when two coherent waves coming out of the slits interfere to each other on the screen. When detector is used in the experiment to detect the traveling particles, the phase angels of the particle waves are changed and the coherency is disturbed, such that interference patterns are interrupted (or disappeared) and diffraction patterns are revealed. However, the interruption of the interference patterns cannot to be used to prove the non-existence of wave property, therefore, Complementarity Principle is not true.

Quantum Superposition

Quantum Superposition is a fundamental principle of quantum mechanics. Any two (or more) quantum states can be added together ("superimposed") and the result will be another valid quantum state; and conversely, that every quantum state can be represented as a sum of two or more other distinct states. Mathematically, it refers to a property of solutions to the Schrödinger equation; since the Schrödinger equation is linear, any linear combination of solutions will also be a solution. A single electron can be represented as a wave function with superposition of two quantum states, spin up and spin down, in Schrödinger equation.

Quantum Entanglement

Quantum entanglement is the physical phenomenon that occurs when a pair or group of particles is generated at the same time, they interact or share spatial proximity in a way such that the quantum state of each particle of the pair or group cannot be described independently of the state of the others, even when the particles are separated by a large distance. Measurements of physical properties such as position, momentum, spin and polarization performed on entangled particles are found to be perfectly correlated. For example, if a pair of entangled particles is generated such that their total spin is known to be zero, and one particle is found to have clockwise spin on a fixed axis, then the spin of the other particle, measured on the same axis, even instantly will be found to be counterclockwise. However, this behavior gives rise to paradoxical effects: (1) The speed of communication could be faster than speed of light (assuming light speed is the limit of speed), (2) Any measurement of a property of an entangled particle results in an irreversible wave function collapse of that particle which can cause interruption of the entanglement and subsequently a random state of the other particle can be measured.

EPR Paradox

In 1935, Albert Einstein, Boris Podolsky, and Nathan Rosen brought up EPR Paradox [8], in which Einstein and others considered quantum entanglement to be impossible unless instant communication can be fulfilled for an infinite distance. It violates the local realism view of causality (Einstein referring to it as "spooky action at a distance") and argued that the accepted formulation of quantum mechanics must therefore be incomplete.

Furthermore, a measurement made on either of the particles apparently collapses the state of the entire entangled system instantaneously before any information about the measurement result could have been communicated to the other particle. According to quantum theory, the outcome of the measurement of the other part of the entangled pair must be taken to be random, with each possibility having a probability of 50%. However, if both spins are measured along the same axis, they are found always to be anti-correlated.

Hidden Variables

Despite the impossible solution that the communication between two particles can be so fast even more than light speed, Einstein proposed a possible resolution to the paradox is to assume that quantum theory is incomplete, and the result of measurements depends on predetermined "Hidden Variables" [9]. The state of the particles being measured contains some hidden variables, whose values effectively determine, right from the moment of separation, what the outcomes of the spin measurements are going to be. This would mean that each particle carries all the required information with it and nothing needs to be transmitted from one particle to the other at the time of measurement. Einstein and others originally believed this was the only way out of the paradox, and the accepted quantum mechanical description with a random measurement outcome must be incomplete.

The weak point in EPR's argument was not discovered until 1964, when John Stewart Bell proved by his inequality that the Hidden Variables interpretation hoped for by EPR, was mathematically inconsistent with the reality. When measurements are made on a large number of pairs of entangled particles, statistically, if the hidden variables view were correct, then the results would always satisfy Bell's Inequality [10]. Since a number of experiments have shown in practice that Bell's Inequality is not satisfied, therefore it is believed that hidden variables are not true and quantum mechanics does comply with Superposition and Complementarity. Even though, some loopholes were found in all those Bell’s Inequality experiments which result in incomplete conclusions. Because of this reason, the spins and entanglements of photons and electrons in optical and magnetic polarization processes are carefully studied. Also, Bell’s Inequality experiments are analyzed in details as follows:

VI. Electron Spin and Entanglement

A. Dual Spins

According to Yangton and Yington Theory, electron has a ball structure [20] which is composed of an outer shell (a cluster of circulating Yingtons) and an inner core (a cluster of rotating Yangtons). It is proposed when electron spins, they can move either in the same directions or the opposite directions. This phenomenon is named “Dual Spins” [21]. In Dual Spin System, there are two major categories: “Up Spin” and “Down Spin” which are defined by the circulation direction of Yington Shell. In addition, there are two minor categories: “Parallel Spin” and “Anti Parallel Spin” which are defined by both directions of Yington Shell and Yangton core. Together, there are a total of four spin modes: Up-Up (U_u) and Up-Down (U_d) modes for Up Spin; and Down-Down (D_d) and Down-Up (D_u) modes for Down Spin (Fig. 6).

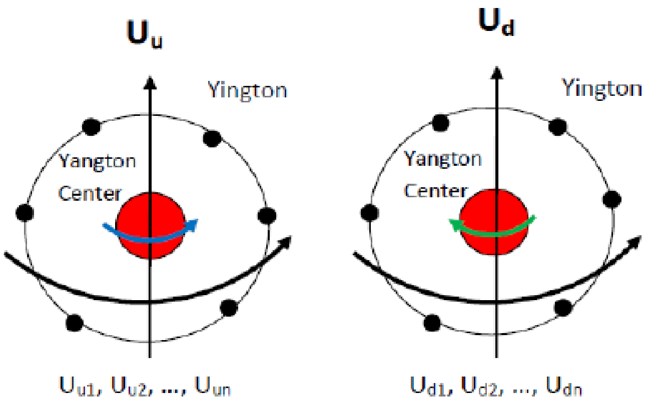


Fig. 6 Electron Spin contains Four Modes: (1) Up Spin: UP-UP (U_u) and UP-Down (U_d) modes, (2) Down Spin: Down-Down (D_d) and Dow-Up (D_u) modes. Each mode contains equal amount of energy states.

B. Quantum States

Subject to the difference of the angular momentums between Yington Shell and Yangton Core, there are a number of quantum states in each of the spin modes. Each quantum state can be represented by a composite code, for example U_u5 means the 5th energy level of Up-Up (U_u) Mode. According to Pauli Exclusion Principle [22], an electron can only occupy one quantum state at a time, therefore a pair of entangled electrons should have quantum states of the same energy but with opposite spin modes such as U_u5 and D_d5. Furthermore, all spin modes shall have equal amounts of quantum states. In addition, it is proposed that anti Parallel spin U_d has higher energy than that of parallel spin U_u (as is D_u and D_d). Also, all electrons prefer to stay in the low energy quantum states rather than the high energy quantum states.

C. Spin Transformation

To measure the electron spin, a magnetic field is applied to the electron in different directions and the electron is detected with either spin up or spin down modes along the measurement directions. Fig. 7 shows an electron spin measurement, where B_1 is the internal magnetic field of the electron, B_2 is the external magnetic field applied by the measurement device and Θ is the angel between B_1 and B_2.

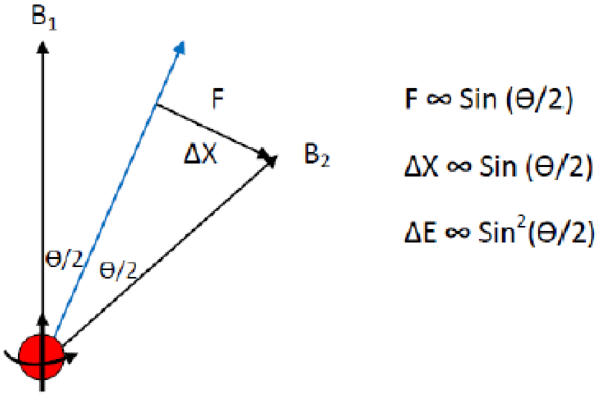


Fig. 7 Force and energy applied on an electron to change its spin direction in the measurement process (transformation).

Through the electron polarization process, energy can be added to electrons while moving into the new magnetic field. However, subject to the total energy, electrons can either flip of to the opposite spin modes (Up to Down or Down to Up) or stay at the same modes. The energy added to electrons during the transformation can be calculated by multiplying the external force $2B_2$ Sin (Θ/2) and the displacement 2L Sin (Θ/2), where B_2 is the magnetic force applied on the electron and L is the particle wavelength of electron.

Because
$F = 2B_2 \text{ Sin}(\Theta/2)$
$dX = 2d(L(\text{Sin}(\Theta/2))) = 2L \text{ Cos}(\Theta/2)\ d(\Theta/2)$
$dE = FdX = 2B_2L\ (\text{Sin}(\Theta/2)\ \text{Cos}(\Theta/2))\ d\Theta$
$E = \int dE = \int 2B_2L\ (\text{Sin}(\Theta/2)\ \text{Cos}(\Theta/2))\ d\Theta$
Integrate from 0^0 to Θ_f
$E = 2B_2L \text{ Sin}^2(\Theta_f/2)$
Therefore,

$$\Delta E \propto \text{Sin}^2(\Theta/2)$$

In Up-Down mode, the highest energy quantum state is EU_dn (Fig. 8). Any quantum state has higher energy than EU_dn will be transformed to Down-Up mode in the new direction, therefore,

$$E_m(\Theta) + \Delta E(\Theta) = E_{Ud}n$$

$$E_m(\Theta) + K\ \text{Sin}^2(\Theta/2) = E_{Ud}n$$

Where $\Delta E(\Theta)$ is the transformation energy added to each energy state which is equal to $K\ \text{Sin}^2(\Theta/2)$. $E_m(\Theta)$ is the threshold energy of the electron polarization transformation. All Up mode electrons having energy higher than the threshold energy can be transformed to the new polarization direction by flipping to Down mode. Otherwise, it will still remain at Up mode after transformation.

Because at $\Theta = 90^o$, all quantum states in Up-Down mode will be transformed to the Down-Up Mode in the new direction (Fig. 8),

$E_m(90^o) = ½\ E_{Ud}n$

$½\ E_{Ud}n + K\ \text{Sin}^2(45^o) = E_{Ud}n$

$K\ \text{Sin}^2(45^o) = ½\ E_{Ud}n$

$$K = E_{Ud}n$$

Where $E_{Ud}n$ is the highest quantum energy state in U_d mode.

Because

$E_m(\Theta) + K\ \text{Sin}^2(\Theta/2) = E_{Ud}n$

Therefore,

$$E_m(\Theta)/E_{Ud}n = \text{Cos}^2(\Theta/2)$$

$$\Delta E(\Theta)/E_{Ud}n = \text{Sin}^2(\Theta/2)$$

Because all the quantum states below $E_m(\Theta)$ will still remain in the same modes after transformation, therefore, the possibility to find the spin up mode (without flipping to the spin down mode) in the new direction can be represented as follows:

$$P(\Theta) = \text{Cos}^2(\Theta/2)$$

Fig. 8 shows a detailed diagram of the electron polarization transformation, in which entangled electron pairs in S direction (Spin Up) and -S direction (Spin Down) are transformed to T direction (Spin Up) and -T direction (Spin Down) in different entangled modes from 0^o to 180^o.

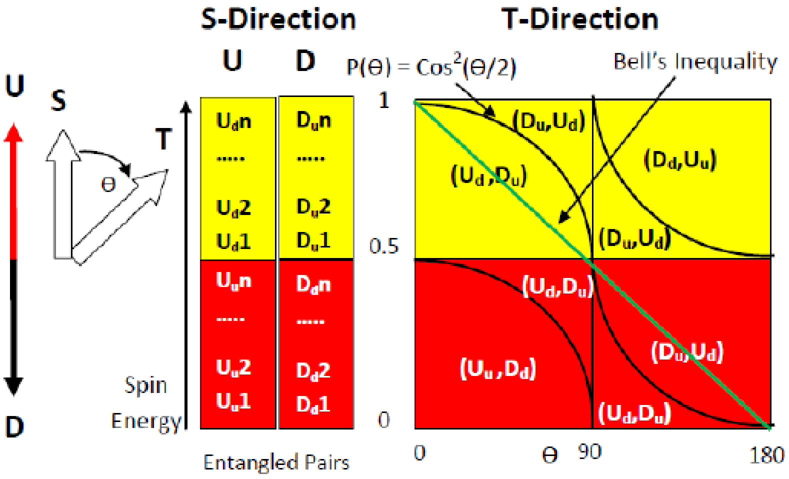


Fig. 8 Quantum Entanglement Phase Diagram: The transformation Diagram of Entangled Electron pairs from S direction to T direction.

A mathematical derivation of this phase diagram is shown as follows:

A. $\Theta < 90^o$
a. $E_{Ud} + \Delta E(\Theta) < E_{Ud}n$
$E_{Ud} + (1 - COS^2 (\Theta/2))\, E_{Ud}n < E_{Ud}n$
$E_{Ud} < COS^2 (\Theta/2)\, E_{Ud}n$
Also,

$U_d \rightarrow U_d$

b. $E_{Ud} + \Delta E(\Theta) \geq E_{Ud}n$
$E_{Ud} + (1 - COS^2 (\Theta/2))\, E_{Ud}n \geq E_{Ud}n$
$E_{Ud} \geq COS^2 (\Theta/2)\, E_{Ud}n$
Also,

$U_d \rightarrow D_u$

c. $E_{Uu} + \Delta E(\Theta) < ½\, E_{Ud}n$
$E_{Uu} + (1 - COS^2 (\Theta/2))\, E_{Ud}n < ½\, E_{Ud}n$
$E_{Uu} < (COS^2 (\Theta/2) - ½)\, E_{Ud}n$
Also,

$U_u \rightarrow U_u$

d. $E_{Uu} + \Delta E(\Theta) \geq ½\, E_{Ud}n$
$E_{Uu} + (1 - COS^2 (\Theta/2))\, E_{Ud}n \geq ½\, E_{Ud}n$
$E_{Uu} \geq (COS^2 (\Theta/2) - ½)\, E_{Ud}n$
Also,

$U_u \rightarrow U_d$

B. $\Theta \geq 90^o$
a. $E_{Uu} + \Delta E(\Theta) \geq E_{Ud}n$
$E_{Uu} + (1 - COS^2 (\Theta/2))\, E_{Ud}n \geq E_{Ud}n$
$E_{Uu} \geq COS^2 (\Theta/2)\, E_{Ud}n$
Also,

$U_u \rightarrow D_u$

b. $E_{Uu} + \Delta E(\Theta) < E_{Ud}n$
$E_{Uu} + (1 - COS^2 (\Theta/2))\, E_{Ud}n < E_{Ud}n$
$E_{Uu} < COS^2 (\Theta/2)\, E_{Ud}n$
Also,

$U_u \rightarrow U_d$

c. $E_{Ud} + \Delta E(\Theta) < (1 + ½)\, E_{Ud}n$
$E_{Ud} + (1 - COS^2 (\Theta/2))\, E_{Ud}n < (1 + ½)\, E_{Ud}n$
$E_{Ud} < (COS^2 (\Theta/2) + ½)\, E_{Ud}n$
Also,

$$U_d \rightarrow D_u$$

d. $E_{Ud} + \Delta E(\Theta) \geq (1 + ½)\, E_{Ud}n$

$E_{Ud} + (1 - COS^2\,(\Theta/2))\, E_{Ud}n \geq (1 + ½)\, E_{Ud}n$

$E_{Ud} \geq (COS^2\,(\Theta/2) + ½)\, E_{Ud}n$

Also,

$$U_d \rightarrow D_d$$

A corresponding identical result can also be derived for Down-Up Mode (D_u) and Down-Down Mode (D_d) (Fig. 8).

In Fig. 8, all entangled electron pairs having predetermined quantum states (Hidden Variables) in S direction can be transformed to a corresponding quantum states in T direction either remaining in the same entangled modes or changing to a counter entangled modes (Up → Down and Down → Up) subject to the transformation processes (measurements at different angles), no matter time and distance. For example: a pair of entangled electrons (U_ux, D_dx) can be transformed to either (U_dy, D_uy) or (D_uz, U_dz). The probability of finding the entangled electrons maintaining their original spin modes after the transformation process (measured at angle Θ) is $P(\Theta) = Cos^2\,(\Theta/2)$. Also, the probability of finding the entangled electrons having opposite spin modes after the transformation process is $1 - P(\Theta) = Sin^2\,(\Theta/2)$. This diagram (Fig. 8) is named "Electron Polarization Transformation Diagram" [21].

Because entangled electron pairs gain energies through polarization processes, they are no longer the same elements prior to the measurements. Before transformation, entangled electrons are in the original sample space with original quantum states (Hidden Variables) and after transformation they enter into a new sample space with new quantum states which is named "Field Dependent Hidden Variables" [23].

VII. Photon Polarization and Entanglement

A. Antimatter Revolution and Rotation Spins (ARRS)

According to Yangton and Yington Theory, photon has a disc structure which is composed of two antimatter particles spinning in opposite directions circulating on the same orbit. It is proposed while Yangton and Yington circulating on the orbit to make revolution spin (photon spin), they can also rotate by them self (Yangton spin and Yington spin). This phenomenon is named "Antimatter Revolution and Rotation Spins" (ARRS) [24]. In ARRS, there are two major spin modes: "Up Spin" – both photon and Yangton spin in the up direction (counterclockwise) and "Down Spin" – both photon and Yangton spin in the down direction (clockwise) (Fig. 9).

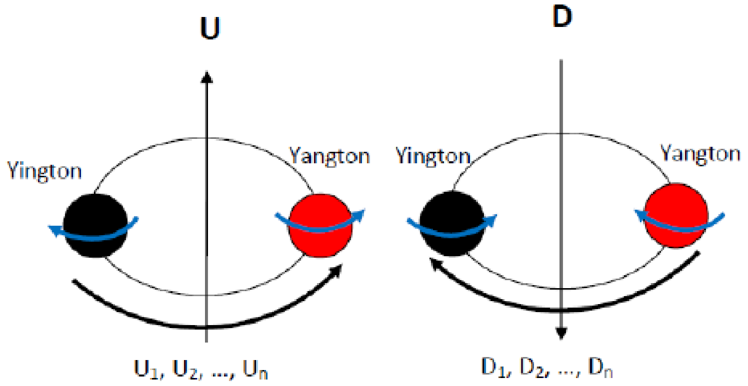


Fig. 9 Photon Spin contains two Modes: (1) Up Spin (2) Down Spin. Each mode contains equal amount of energy states.

B. Quantum States

Subject to the difference of the angular momentums between Yangton and Yington, there are a number of quantum states in each of the spin modes. Each quantum state can be represented by a composite code, for example U5 means the 5th energy level of Up Mode. According to Pauli Exclusion Principle [22], a photon can only occupy one quantum state at a time, therefore a pair of entangled photons should have quantum states of the same energy but with opposite spin modes such as U5 and D5. Furthermore, both spin up and spin down modes shall have equal amounts of quantum states. Also, all photons prefer to stay in the low energy quantum states rather than the high energy quantum states.

C. Polarization Transformation

When photons transform between two polarization directions, they have to overcome a corresponding energy barrier with their internal energy. Fig. 10 shows a photon transformation between two polarization directions, where B_1 is photon's original polarization direction, B_2 is photon's new polarization direction and Θ is the angel between B_1 and B_2.

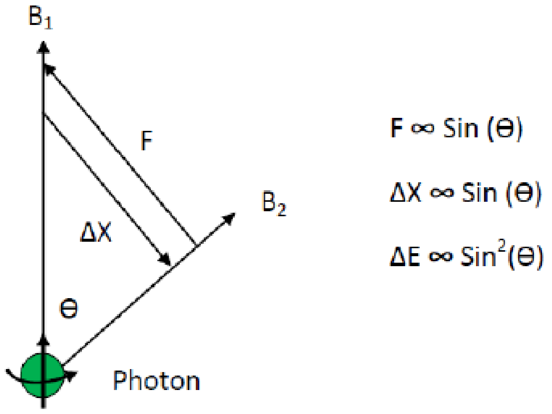


Fig. 10 Force and energy applied from a photon to change its original spin direction to a new polarization direction.

The energy barrier ΔE can be calculated by multiplying the external force B Sin (Θ) and the displacement L Sin (Θ), where B is the original polarization force of the photon and L is the wavelength of the photon. Since the external force and displacement are in the opposite directions, energy barrier ΔE is a negative energy which is the energy reduced from photon through polarization process.

Because

$F \infty \mathrm{Sin}\,(\Theta)$

$\Delta X \infty \mathrm{Sin}\,(\Theta)$

$\Delta E = F\, \Delta X$

Therefore,

$$\Delta E \infty \mathrm{Sin}^2(\Theta)$$

Because only those photons in Up mold having higher energy than ΔE (energy barrier) (Fig. 11) and can be transformed to the same Up mode in the new polarization direction, therefore,

$$E_m(\Theta) = \Delta E(\Theta)$$

$$E_m(\Theta) = K\, \mathrm{Sin}^2(\Theta)$$

Where $E_m(\Theta)$ is the threshold energy which is equal to $\Delta E(\Theta)$ the energy barrier of photon polarization transformation. All Up mode photons having energy higher than the threshold energy $E_m(\Theta)$ can be transformed to the new polarization direction remaining the same Up mode. Otherwise, it will be blocked by the energy barrier and cannot enter into the new polarization direction.

Because at $\Theta = 90^o$, all photons in the Up mode are blocked by the polarizer and no light can be transformed to the new polarization direction by passing through the polarizer, therefore,

$E_m(90^o) = E_{Un}$

$K\, \mathrm{Sin}^2\,(90^o) = E_{Un}$

$$K = E_{Un}$$

Because

$E_m(\Theta) = K\, \mathrm{Sin}^2(\Theta)$

Therefore,

$$E_m(\Theta)/E_{Un} = Sin^2(\Theta)$$

Where E_{Un} is the highest quantum energy state in Up mode.

Because all photons with quantum states above $Sin^2(\Theta)\ E_{Un}$ can be transferred to the new polarization direction, therefore, the possibility to find the photons in the polarization direction (Θ) can be represented as:

$$P(\Theta\ ) = Cos^2(\Theta)$$

Fig. 11 shows a detailed diagram of photon polarization transformation, in which entangled photon pairs in S direction (Spin Up) and -S direction (Spin Down) are transformed to T direction (Spin Up) and -T direction (Spin Down) in different entangled modes from 0^o to 90^o.

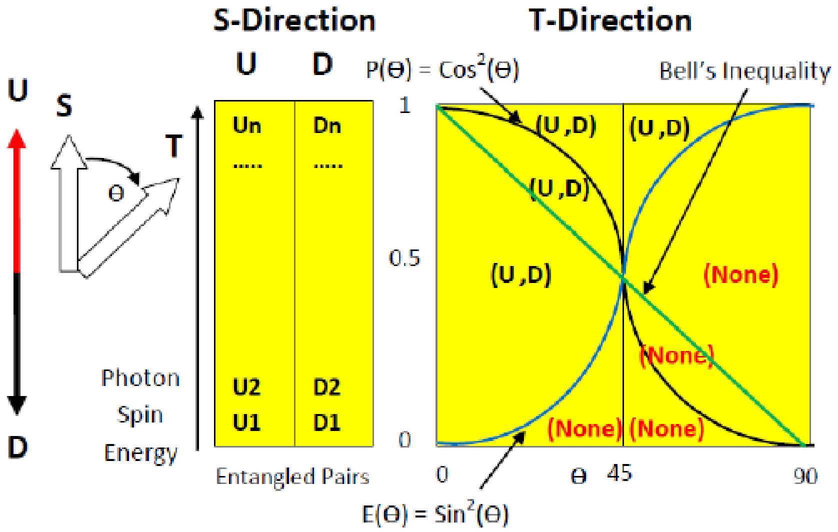


Fig. 11 Photon Polarization Transformation Diagram: The Transformation Diagram of Entangled Photon pairs from S direction to T direction.

All entangled photons in the original S polarization direction (and –S polarization direction) occupy a predetermined quantum energy state (U_x, D_x) (Hidden Variables). Subject to the angle between two polarizers, those photons that have higher energy than the polarization transformation energy barrier $\Delta E(\Theta) = Sin^2(\Theta)\ E_{Un}$ can overcome the energy barrier and pass through the T polarizer (and –T polarizer), then transform to a lower quantum energy states (U_y, D_y) in T polarization direction (and –T polarization direction) with their original spin modes maintained no matter time and distance. On the other hand, those photons having lower energy than the energy barrier will be blocked by the T polarizer (and –T polarizer). The possibility to find photons passing through the T polarizer at a polarization angle Θ is $P(\Theta\ ) = Cos^2(\Theta)$ and the possibility of the photons blocked by the polarizer is $1 - P(\Theta\ ) = Sin^2(\Theta)$. This diagram (Fig. W) is named "Photon Polarization Transformation Diagram" [24].

Because entangled photon pairs lost energies through polarization processes, they are no longer the same elements prior to the measurements. Before transformation, entangled photons are in the original sample space with original quantum states (Hidden Variables) and after transformation they enter into a new sample space with new quantum states (Field Dependent Hidden Variables) [23].

Bell's Inequality

Bell's Inequality is a mathematical theory based on Set Theory as illustrated in Fig.12. Bell's Inequality is true only if all the elements are in the same sample space and have predetermined variables. In case of photon polarization, when a light beam passing through three polarizers with polarization angles A = 0^o, B = 22.5^o and C = 45^o, the intensity of the transmitted light can be shown in Table 1 [24] . Where "Real Transmission" is the actual measurement results and "Bell Transmission" is the theoretical results based on

Bell's Inequality. Because the actual measurement results of Real Transmission are different from that of Bell Transmission, therefore, Bell claimed that Hidden Variables doesn't exist and cannot be the solution of EPR Paradox. In other words, according to Bell, quantum theories such as Superposition Theory and Complementarity Principle must be true.

Bell's Inequality sounds great, but a necessary (must) condition of Bell's Inequality is missing, that is "In Set Theory, which is the basis of Bell's Inequality, all elements in the sample space must stay unchanged (keeping the same sample space) no matter the distribution and future transformation of the elements". In polarization experiments, energy is first added to electrons or reduced from photons during the polarization processes, then further normalized in the subsequent polarization processes. In other words, the elements (photons and electrons) used in the calculation of Bell's Inequality are taken from mixed sample spaces instead from the same sample space. Therefore, all efforts in polarization experiments using Bell's Inequality to prove that Hidden Variables doesn't exist are in vain [25]. As to the quantum entanglement experiments, because all the elements are taken from the same sample space, therefore Bell's Inequality should be hold and the existence of Hidden Variables can be proven. But, in reality, because of the inaccurate analysis, a number of false results were reported which have caused a lot of misunderstandings and confusions.

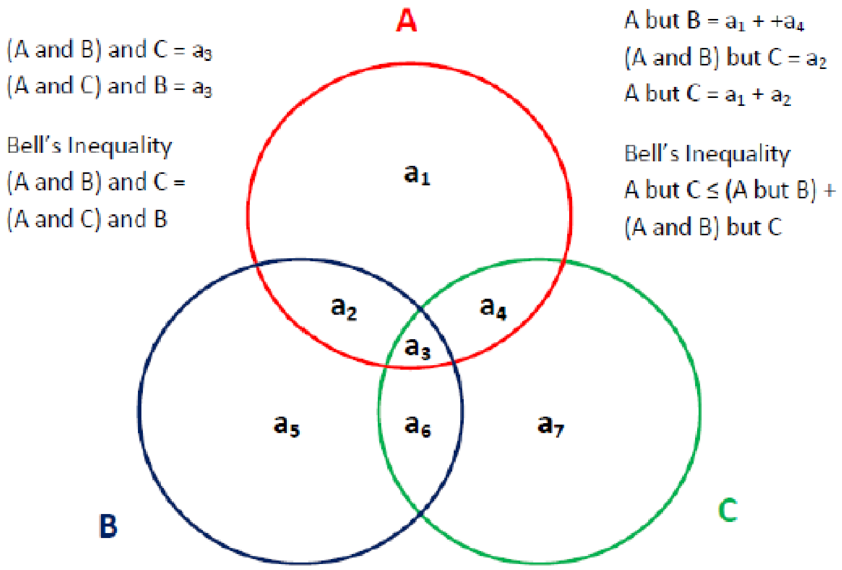


Fig. 12 Bell's Inequality Diagram – The distribution of elements in three domains (sets). All elements must stay unchanged no matter of distribution.

Field Dependent Hidden Variables

According to the models of photon and electron based on Yangton and Yington Theory, all photons and electrons should have their predetermined quantum energy states which is so called "Hidden Variables" [26] [21].

Through polarization process either by optical polarizer for photons or magnetic field for electrons, subject to the polarization strength based on the polarization angle, an energy barrier (for photon) [26] or a threshold energy (for electron) [21] can be established. In case of optical polarization, for those photons which have energy higher than the energy barrier (dependent on the polarization angle) will pass through the polarizer and keep the same polarization direction as the polarizer, or otherwise, they will be completely blocked by the polarizer. In case of magnetic polarization, for those electrons which have initial energy higher than the threshold energy (dependent on the polarization angle) will gain the polarization energy (provided by magnetic field) to overcome the energy barrier and flip of to the opposite spin direction, or otherwise, they will maintain the original spin mode in the new polarization direction.

The original quantum energy states (Hidden Variables) of the electrons generated by polarizer A forms the "Original Sample Space" (Hidden Variables Sample Space). In the subsequent polarization processes (such as those of polarizer B or polarizer C), new quantum energy states are generated which is called "Field Dependent Hidden Variables" [23], to form "New Sample Space" (Field Dependent Hidden Variables Sample

Space) for further normalization polarization processes. Field Dependent Hidden Variables are determined by the original quantum energy states (Hidden Variables) and polarization fields (polarization angles).

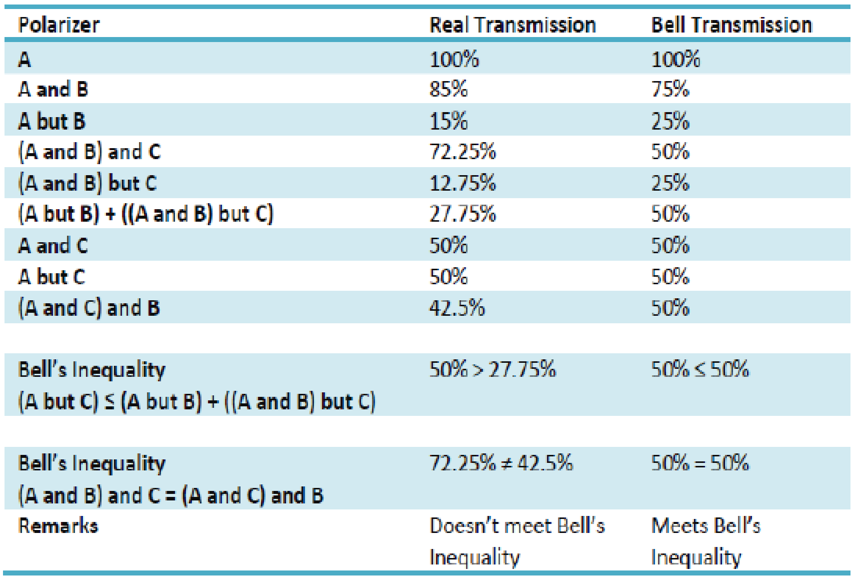
Because all photons (and electrons) in different quantum energy states have equal opportunity to be emitted from the light (electron) sources, the probability to find the photons either pass through or block out by the polarizer, or the electrons either spin up or spin down by the magnetic polarizer, is also dependent on the polarization fields (polarization angles) of the polarization processes (measurements), such as $P(\Theta) = Cos^2(\Theta)$ in photon polarization process (Fig. 11) and $P(\Theta) = Cos^2(\Theta/2)$ in electron polarization process (Fig. 8). These probabilities are used for the analysis in Bell's Inequality Experiments.

Principle of Normalization

In optical polarization (for photon) and magnetic polarization (for electron) processes, before transformations, both photons and electrons have their fixed quantum energy states (Hidden Variables). After transformations by adding energy to electrons or reducing energy from photons, new quantum energy states (Field Dependent Hidden Variables) are generated. In a sequential polarization processes, the same distribution patterns of the Field Dependent Hidden Variables upon the polarization strengths (polarization angles) are generated for each polarization process. This phenomenon is named "Principle of Normalization" [23].

Table 1 show that in reality polarization transformations always obey Principle of Normalization. For example, the ratio of photons passing through B polarizer (22.5^o from A polarizer) noted as "A and B" is 85%, and the ratio of these photons passing through another C polarizer (22.5^o from B polarizer and 45^o from A polarizer) noted as "(A and B) and C" is 72.25% (because 85% x 85% = 72.25%). It is bigger than the ratio of photons passing only through C polarizer noted as "A and C" which is 50%. It is also different from the ratio of photons passing through C polarizer then B polarizer noted as "(A and C) and B" which based on Principle of Normalization is 42.5% (because 50% x 85% = 42.5%).

Table 1 The Real Transmission and Bell Transmission of three polarizers with polarization angels $A = 0^o$, $B = 22.5^o$, $C = 45^o$.



Polarizer	Real Transmission	Bell Transmission
A	100%	100%
A and B	85%	75%
A but B	15%	25%
(A and B) and C	72.25%	50%
(A and B) but C	12.75%	25%
(A but B) + ((A and B) but C)	27.75%	50%
A and C	50%	50%
A but C	50%	50%
(A and C) and B	42.5%	50%
Bell's Inequality **(A but C) ≤ (A but B) + ((A and B) but C)**	50% > 27.75%	50% ≤ 50%
Bell's Inequality **(A and B) and C = (A and C) and B**	72.25% ≠ 42.5%	50% = 50%
Remarks	Doesn't meet Bell's Inequality	Meets Bell's Inequality

Bell's Inequality Experiments

The proof of the existence of Hidden Variables is a big challenge. However, based on "Set Theory", all photons and electrons with Hidden Variables (quantum energy states) in the same sample space can be used to form a variety of sets which should obey Bell's Inequalities. Therefore, if there is any set of photons and electrons that doesn't satisfy Bell's Inequality, then it can be used as a proof of that Hidden Variables don't exist. Because of this reason, a variety of experiments were designed and carried out by different groups of scientists, trying to prove that there is no such things as predetermined variables (Hidden Variables) in photons and electrons, so they can confirm that Quantum Superposition is correct and Einstein's EPR Paradox is wrong. Those experiments can be classified into two categories: polarization experiments and quantum entanglement experiments. They are carefully studied and analyzed as follows:

A. Polarization Experiments (Mixed Sample Spaces)

In photon polarization and electron polarization experiments, the photons and electrons emitted from a coherent source, carry the Hidden Variables (energy states) contained in a Hidden Variables Sample Space (A group of elements formed by the emitted photons and electrons respectively). In subsequent polarization process, they can be transformed to the Field Dependent Hidden Variables in a Field Dependent Hidden Variables Sample Space. Similarly, in further polarization process, they can be transformed to the Normalized Field Dependent Hidden Variables in a Normalized Field Dependent Hidden Variables Sample Space. All these hidden variables are different, same as their sample spaces.

According to Set Theory, Bell's Inequality can only apply to the same sample space. However, in the actual photon polarization experiments, the elements (photons and electrons) are taken from mixed sample spaces instead of the same sample space for the calculation of Bell's Inequality, therefore the results obtained from the photon polarization experiments cannot be used to prove if Hidden Variables exist or not [23].

For examples, in Table 1, "A and B" and "A and C" are transformed from the same Hidden Variables Sample Space generated by polarizer A. However, "(A and B) and C" and "(A and C) and B" are transformed from different Field Dependent Hidden Variables Sample Spaces. The sample space of "(A and B) and C" is the Field Dependent Hidden Variables Sample Space generated by polarizer B which is different from the sample space of "(A and C) and B" which is the Field Dependent Hidden Variables Sample Space generated by polarizer C.

A comparison between Bell's Inequalities obtained from the same sample space and that from the mixed sample spaces can be shown as follows:

For the same sample space, Bell's Inequalities based on Set Theory can be formulated as follows (Fig. 12) (Table 1):

$(A\cap B)\cap C = (A\cap C)\cap B$
$(A\cap -C) \le (A\cap -B) + (A\cap B)\cap -C$
$(A\cap B)\cap C \le A\cap C$

Where $\cap$ is "AND" operation in Set Theory.

However, for mixed sample spaces, Bell's Inequalities can be different:

$(A\cap B)\cap C > (A\cap C)\cap B$
$(A\cap -C) > (A\cap -B) + (A\cap B)\cap -C$
$(A\cap B)\cap C > A\cap C$

Where $(A\cap B)$, $(A\cap -B)$, $(A\cap C)$ and $(A\cap -C)$ have the same original Hidden Variables Sample Space. The sample space of $(A\cap B)\cap C$ is the Field Dependent Hidden Variables Sample Space generated by polarizer B and the sample space of $(A\cap C)\cap B$ is the Field Dependent Hidden Variables Sample Space generated by polarizer C.

Fig. 13 shows the effects of mixed sample spaces on Bell's Inequalities. With mixed sample spaces, $(A\cap B)\cap C$ can be larger than $(A\cap C)$ which violates Set Theory.

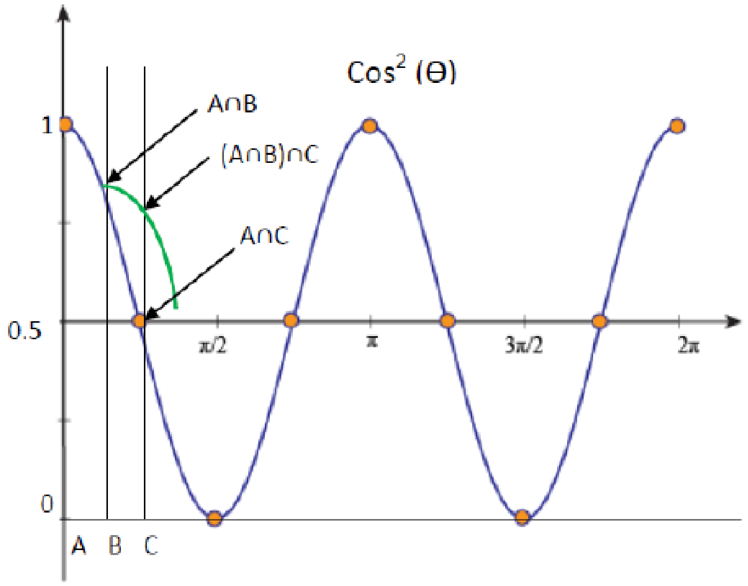


Fig. 13 The effects of different sample spaces on Bell's Inequality in photon polarization experiments. (A∩C) < (A∩B)∩C is due to the mixed sample spaces Hidden Variables and Field Dependent Hidden Variables.

As a result, the claim "There are no Hidden Variables in photons and electrons" based on Bell's Inequalities calculated with mixed sample spaces is not true.

B. Quantum Entanglement Experiments (Same Sample Space)

According to Set Theory, in the same sample space, all sets containing elements with hidden variables should fulfill Bell's Inequalities. Therefore, the whole purpose of those Quantum Entanglement Experiments is trying to find one exception which doesn't meet Bell's Inequality so as to prove that Hidden Variables do not exist in entangled electrons and photons.

In Quantum Entanglement Experiments, all elements (entangled electrons with Hidden Variables) are coming from the same sample space (space of Hidden Variables) generated by an electron source. Polarizer is used to form sets (groups of elements) with electrons positioned either inside the set (say spin up) or outside the set (spin down). Since all these sets contain the elements (electrons) from the same Hidden Variables Sample Space (light source), therefore Bell's Inequality should always hold for these sets such that the existence of Hidden Variables can be proved. But, in reality, because of the inaccurate data are used for analysis, a number of false results are reported which have caused a lot of misunderstandings and confusions.

In Electron Entanglement Experiments [27], a pair of entangled electrons is generated from an electron source and is emitted separately to the electron spin detectors in Alice's and Bob's laboratories. Three magnetic polarizers with polarization angles 120° apart from each other ($P_1=\Phi$, $P_2=\Phi+120^o$ and $P_3=\Phi+240^o$, where Φ is the angle between the original electron e and P_1 polarizer at Alice's laboratory) are used for detection and each time a magnetic polarizer is randomly chosen by Alice and Bob respectively for measurements.

There are two different types of electron sources, coherent and random. Also there are two different sets of polarizers, Alice and Bob can use the same set ($P_1=\Phi$, $P_2=\Phi+120^o$, $P_3=\Phi+240^o$), or otherwise Bob can use the opposite set ($P_1=\Phi+180^o$, $P_2=\Phi+300^o$, $P_3=\Phi+60^o$).

Coherent Electron Source

Because the possibility to find the same spin as that of the original electron passing through a magnetic polarizer at angle Θ is $\mathrm{Cos}^2(\Theta/2)$ (Fig. 8) [21], where Θ is the angle between the magnetic polarization directions of the original electron and the magnetic polarizer. Therefore, the total possibilities P (Φ) to find the same spin as the original electron from a coherent electron source passing through either one of the three polarizers (Φ, $\Phi+120^o$, $\Phi+240^o$) (Fig. 14) can be calculated as follows:

$$P(\Phi) = [\mathrm{Cos}^2(\Phi/2) + \mathrm{Cos}^2(\Phi/2 + 120^o/2) + \mathrm{Cos}^2(\Phi/2 + 240^o/2)]/3$$

Because

$\text{Cos}\ (\Theta+\Phi) = \text{Cos}\ \Theta\ \text{Cos}\ \Phi - \text{Sin}\ \Theta\ \text{Sin}\ \Phi$

Therefore,

$$P\ (\Phi\ ) = 50\%$$

As a result, with coherent electron source, the possibility to find the same spin as the original electron passing through either one of the three magnetic polarizers (Φ, $\Phi+120^o$, $\Phi+240^o$) is always 50%.

1. Random Electron Source

The possibility to find the same spin as the original electron passing through either one of the three magnetic polarizers (Φ, $\Phi+120^o$, $\Phi+240^o$) from a random electron source is the average of the integration of $P(\Phi)$ from 0 to 2π,

$P = 1/2\pi\ \int 1/3[\text{Cos}^2(\Phi/2) + \text{Cos}^2(\Phi/2 + 120^o/2) + \text{Cos}^2(\Phi/2 + 240^o/2)]\ d\Phi$

$$P = 50\%$$

As a result, with random electron source, the possibility to find electrons with the same spin as the original electron passing through either one of the three magnetic polarizers (Φ, $\Phi+120^o$, $\Phi+240^o$) is also 50% [27].

2. Opposite Polarizers

Furthermore, the entangled electron goes to Alice's laboratory is spin up and measured randomly by either one of the three magnetic polarizers (Φ, $\Phi+120^o$ and $\Phi+240^o$), and the other entangled electron goes to Bob's laboratory must be spin down and is measured randomly by either one of the opposite set of three magnetic polarizers ($\Phi+180^o$, $\Phi+300^o$, $\Phi+60^o$). For both coherent source and random electron source, the possibility that Bob will find spin down electrons is 50%, also spin up electrons is 50%. As a result, for both coherent source and random electron source, the total possibility that Alice and Bob will find the same spins (either both spin up or both spin down) is 50%. Also, the total possibility to find the opposite spins (either Alice spin up and Bob spin down or vise versa) is again 50% [27].

3. Same Polarizers

Assuming Bob using the same set of magnetic polarizers as Alice, then two cases are studied here: Case A ($\Phi = 0^o$), where the polarization direction of the original entangled electron "e" coming to Alice's laboratory is the same as P_1 magnetic polarizer; and Case B ($\Phi = 180^o$), where the polarization direction of the original entangled electron "e" coming to Alice's laboratory is opposite to P_1 magnetic polarizer.

a. Case A ($\Phi = 0^o$)

In case the polarization direction of P_1 magnetic polarizer is the same ($\Phi = 0^o$) as the original electron "e" coming to Alice's laboratory, then Fig. 14 shows the possibilities of finding spin up electrons with either of the three magnetic polarizers in Alice's laboratory (the original electron "e" is spin up) and the possibility of finding spin down electrons in Bob's laboratory (because of the entanglement, the original electron "$\underline{e}$" coming to Bob's laboratory is spin down). Where P_1, P_2 and P_3 are the three magnetic polarizers having angles 0^o, 120^o and 240^o apart from the polarization direction of "e" in Alice laboratory, and 180^o, 300^o and 60^o apart from "$\underline{e}$" in Bob's laboratory.

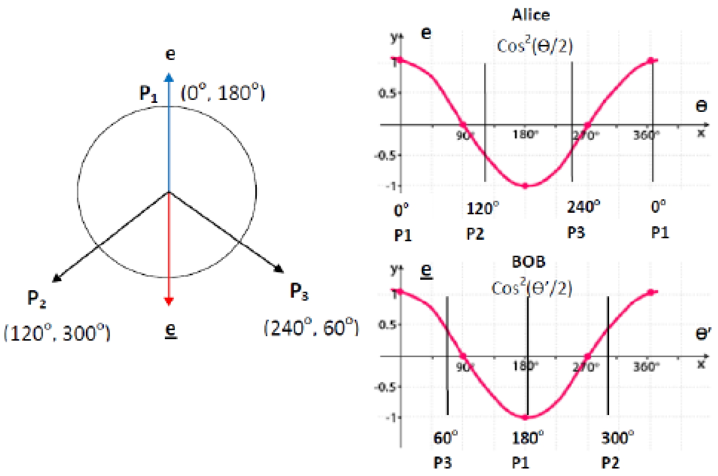
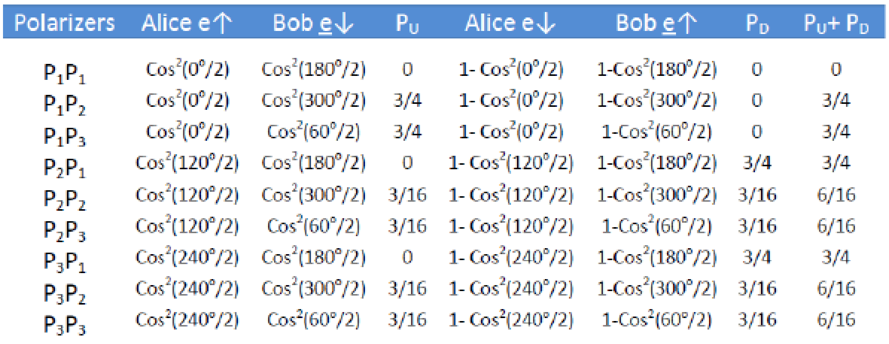


Fig. 14 The possibilities of spin up at Alice's and spin down at Bob's laboratories (at Φ = 0°, Φ is the angle between the original electron e (spin up) and P_1 at Alice's laboratory).

Table 2 shows the possibilities of finding opposite spins with different combinations of magnetic polarizers (P_xP_y) between Alice's and Bob's laboratories. Where P_U is the possibility of finding spin up in Alice's laboratory and spin down in Bob's laboratory, and P_D is the possibility of finding spin down in Alice's laboratory and spin up in Bob's laboratory.

Table 2 ne possibilities of opposite spins observed by Alice and Bob at Φ = 0°. (Where Φ is the angle between the original electron (spin up) and P_1 polarizer at Alice's laboratory)



Polarizers	Alice e↑	Bob e̲↓	P_U	Alice e↓	Bob e̲↑	P_D	P_U+ P_D
P_1P_1	$Cos^2(0^o/2)$	$Cos^2(180^o/2)$	0	$1- Cos^2(0^o/2)$	$1-Cos^2(180^o/2)$	0	0
P_1P_2	$Cos^2(0^o/2)$	$Cos^2(300^o/2)$	3/4	$1- Cos^2(0^o/2)$	$1-Cos^2(300^o/2)$	0	3/4
P_1P_3	$Cos^2(0^o/2)$	$Cos^2(60^o/2)$	3/4	$1- Cos^2(0^o/2)$	$1-Cos^2(60^o/2)$	0	3/4
P_2P_1	$Cos^2(120^o/2)$	$Cos^2(180^o/2)$	0	$1- Cos^2(120^o/2)$	$1-Cos^2(180^o/2)$	3/4	3/4
P_2P_2	$Cos^2(120^o/2)$	$Cos^2(300^o/2)$	3/16	$1- Cos^2(120^o/2)$	$1-Cos^2(300^o/2)$	3/16	6/16
P_2P_3	$Cos^2(120^o/2)$	$Cos^2(60^o/2)$	3/16	$1- Cos^2(120^o/2)$	$1-Cos^2(60^o/2)$	3/16	6/16
P_3P_1	$Cos^2(240^o/2)$	$Cos^2(180^o/2)$	0	$1- Cos^2(240^o/2)$	$1-Cos^2(180^o/2)$	3/4	3/4
P_3P_2	$Cos^2(240^o/2)$	$Cos^2(300^o/2)$	3/16	$1- Cos^2(240^o/2)$	$1-Cos^2(300^o/2)$	3/16	6/16
P_3P_3	$Cos^2(240^o/2)$	$Cos^2(60^o/2)$	3/16	$1- Cos^2(240^o/2)$	$1-Cos^2(60^o/2)$	3/16	6/16

For example, with P_2P_3 combination (Alice uses P_2 magnetic polarizer and Bob uses P_3 magnetic polarizer),

$P_U = Cos^2(120^o/2)\ Cos^2(60^o/2) = (1/2)^2\ (3^{1/2}/2)^2 = 3/16$

$P_D = [1- Cos^2(120^o/2)]\ [1- Cos^2(60^o/2) = (3/4)\ (1/4) = 3/16$

$P_U + P_D = 6/16$

Therefore, the total possibility P of finding opposite spins between Alice and Bob can be calculated as follows:

$P = 1/9\ \Sigma(P_U + P_D)$

$P = 50\%$

As a result, in case the polarization direction of the original electron coming to Alice's laboratory is the same as P_1 magnetic polarizer ($\Phi = 0^o$), then the total possibility of finding opposite spins between Alice and Bob is 50%, and the total possibility of finding the same spins is also 50% [27].

b. Case B ($\Phi = 180^o$)

In case the polarization direction of P_1 magnetic polarizer is opposite ($\Phi = 180^o$) to the original electron "e" coming to Alice's laboratory, then Fig. 15 shows the possibilities of finding spin up electrons in Alice's laboratory (the original electron "e" is spin up) and the possibility of finding spin down electrons in Bob's laboratory (because of the entanglement, the original electron "$\underline{e}$" coming to Bob's laboratory is spin down). Where P_1, P_2 and P_3 are the three polarizers with angles 180^o, 300^o and 60^o apart from "e" in Alice's laboratory, and 0^o, 120^o and 240^o apart from "$\underline{e}$" in Bob's laboratory.

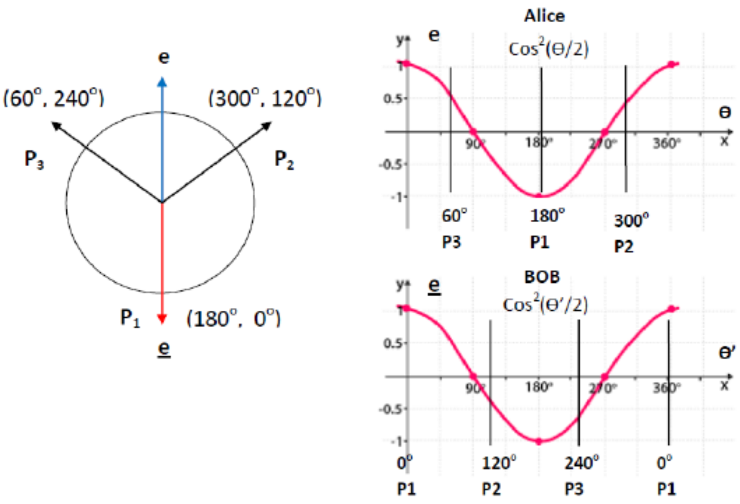


Fig. 15 The possibilities of spin up at Alice's and spin down at Bob's laboratories (at $\Phi = 180^o$, Φ is the angle between the original electron e (spin up) and P_1 at Alice's laboratory).

Table 3 shows the possibilities of finding opposite spins with different combinations of magnetic polarizers (P_xP_y) between Alice's and Bob's laboratories. Where P_U is the possibility of finding spin up in Alice's laboratory and spin down in Bob's laboratory, and P_D is the possibility of finding spin down in Alice's laboratory and spin up in Bob's laboratory. Therefore,

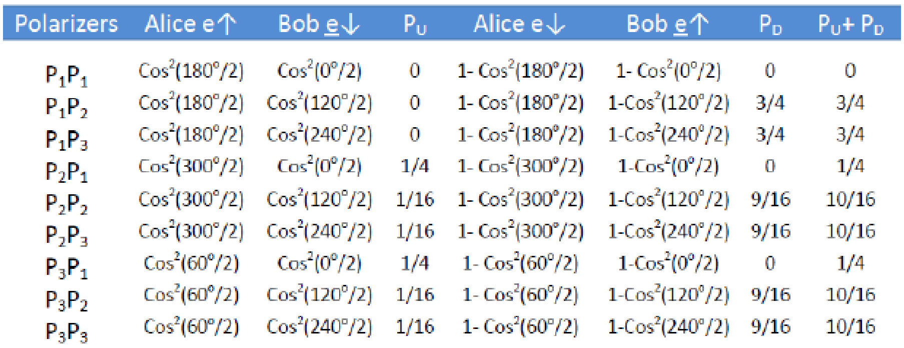
$P = 1/9\ \Sigma(P_U + P_D)$

$P = 50\%$

Where P is the total possibility of finding opposite spins between Alice's and Bob's laboratories.

As a result, in case the polarization direction of Alice's P_1 polarizer is opposite (180^o) to the original electron coming to Alice's laboratory, again the total possibility of finding opposite spins between Alice and Bob is 50%, and the total possibility of finding the same spins is also 50% [108]. Similarly, the same results can be obtained for the original electron coming to Alice's laboratory at different angels between 0^o to 180^o.

Table 3 The possibilities of opposite spins observed by Alice and Bob at Φ = 180°. (Where Φ is the angle between the original electron (spin up) and P_1 polarizer at Alice's laboratory)



Polarizers	Alice e↑	Bob e↓	P_U	Alice e↓	Bob e↑	P_D	P_U+ P_D
P_1P_1	$Cos^2(180°/2)$	$Cos^2(0°/2)$	0	$1- Cos^2(180°/2)$	$1- Cos^2(0°/2)$	0	0
P_1P_2	$Cos^2(180°/2)$	$Cos^2(120°/2)$	0	$1- Cos^2(180°/2)$	$1-Cos^2(120°/2)$	3/4	3/4
P_1P_3	$Cos^2(180°/2)$	$Cos^2(240°/2)$	0	$1- Cos^2(180°/2)$	$1-Cos^2(240°/2)$	3/4	3/4
P_2P_1	$Cos^2(300°/2)$	$Cos^2(0°/2)$	1/4	$1- Cos^2(300°/2)$	$1-Cos^2(0°/2)$	0	1/4
P_2P_2	$Cos^2(300°/2)$	$Cos^2(120°/2)$	1/16	$1- Cos^2(300°/2)$	$1-Cos^2(120°/2)$	9/16	10/16
P_2P_3	$Cos^2(300°/2)$	$Cos^2(240°/2)$	1/16	$1- Cos^2(300°/2)$	$1-Cos^2(240°/2)$	9/16	10/16
P_3P_1	$Cos^2(60°/2)$	$Cos^2(0°/2)$	1/4	$1- Cos^2(60°/2)$	$1-Cos^2(0°/2)$	0	1/4
P_3P_2	$Cos^2(60°/2)$	$Cos^2(120°/2)$	1/16	$1- Cos^2(60°/2)$	$1-Cos^2(120°/2)$	9/16	10/16
P_3P_3	$Cos^2(60°/2)$	$Cos^2(240°/2)$	1/16	$1- Cos^2(60°/2)$	$1-Cos^2(240°/2)$	9/16	10/16

Most Bell's Inequality experiments take 50% - 50% spin up and spin down possibilities for each photon and electron passing through the polarizer, instead of $Cos^2(\Theta/2)$ for spin up electrons and $Cos^2(\Theta)$ for spin up photons. It is obviously a big mistake. Therefore, the claim that "Because the experimental results don't fulfill Bell's Inequality, therefore Hidden Variables don't exist" is totally false. In fact, with the correct data, all experiments should fulfill Bell's Inequality. As a result, Hidden Variables do exist in both entangled electrons and photons, and Superposition is not true at all.

VIII. Conclusion

In compliance with Wave Particle Duality, based on Yangton and Yington Theory, both wave and particle properties can coexist in a spinning polarized particle such as photon or electron, no matter the environment and location. In Double Slit Interference experiment, particle detector can be used to influence the phase angles of particle waves such that the coherency is disturbed and the interference patterns are diminished or even totally disappeared. However, the interruption of the interference patterns cannot to be used to prove the non-existence of wave property, or even to prove that wave and particle properties cannot coexist at the same time under observation. Therefore, "Complementarity Principle" is not true.

In addition, both photon and electron have predetermined quantum energy states (Hidden Variables). In electron spin measurements, energy can be added to electrons through electron polarization process. Subject to the threshold energy, electrons can move to the new quantum energy states (Field Dependent Hidden Variables) either by staying at the same spin mode or flipping of to the opposite spin mode. On the other hand, in photon polarization measurements, energy can be removed from photons through photon polarization process. Subject to the threshold energy, photons can either enter into the new quantum energy states (Field Dependent Hidden Variables) by maintaining the same spin mode or totally blocked by the energy barrier. Even more, through further transformations, both photons and electrons can be transferred to normalized quantum energy states (Normalized Field Dependent Hidden Variables).

In Quantum Entanglement experiments, both entangled photons and electrons have the same Hidden Variables except in opposite spin directions. Under the same polarization transformation processes (measurements), they both gain or lose the same energies as passing through the same threshold energy barriers and have the same Field Dependent Hidden Variables except in the opposite spin directions. Therefore, they are always entangled no matter how far the distance and how fast the time are.

Bell's Inequality is based on Set Theory and can only be applied on the same sample space. Therefore, in photon polarization experiments, Bell's Inequality applying on the mixed sample spaces cannot be used to prove if Hidden Variables exist or not. On the other hand, in Quantum Entanglement experiments, with the right experimental data, Bell's Inequality applying on the same sample space does approve the existence of the Hidden Variables. As a result, both electron and photon do carry predetermined Hidden Variables, and Schrödinger's Cat cannot be both alive and dead at the same time. Therefore, "Quantum Superposition" cannot be true. Also, there is no mystery, no surprise and certainly no "Spooky" behavior. Einstein is correct after all.

Even though Quantum Mechanics has been misinterpreted by several famous scientists in the past decades, also a serious challenge has been raised to against Superposition and Complementarity Principles – the heart of Quantum Mechanics, still Quantum Mechanics is a very well established scientific theory based on the quantized properties of particles and the probability and statistic natures of multiple quantum states.

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