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Hidden Variables Based on Quantum Energy States Proved by Probability of Polarization Transformation Instead of Bell's Inequality

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[Abstract]
Many Bell's Inequality experiments including the one received 2022 Nobel Prize in physics were attempted to prove that Bell's Inequalities cannot fulfill the experimental results, such that Einstein's Hidden Variables couldn't exist and quantum superposition and quantum entanglement are true. However, in photon multiple polarization experiments, because the data are taken from mixed sample spaces which opposes to the fundamental principle of Set Theory, the base of Bell's Inequality, therefore they can't be used to calculate Bell's Inequalities and to disapprove Hidden Variables. On the other hand, in electron entanglement experiments, because the Bell Inequalities applied are in lack of probability of polarization transformation and the experiments used have a variety of loopholes, therefore many faults are found in the analyses. As a result, the conclusions of Bell's Inequality Experiments are incomplete.
Based on Yangton and Yington Theory, quantum energy states generated by the spinning of photon and electron are proposed as the Hidden Variables. To prove the existence of these Hidden Variables, instead of the indirect proves by the confusing and complicated Bell's Inequality, a direct proves by actual experiments can be applied. Subject to the spin model and transformation mechanism of photon and electron, threshold energy of polarization transformation can be derived, which should be equal to the probability of polarization transformation and as is the measured ratio of polarization transformation. This correlation can be proved by experiments, which confirms that quantum energy states are the Hidden Variables. In addition, complying with probability of transformation, a quantum entanglement experiment with two detectors and three polarizers is studied. Again, the agreement between the calculated probability of polarization transformation and the measured ratio of polarization transformation for mixed patterns confirms that quantum energy states are indeed the Hidden Variables.
Furthermore, when a pair of entangled electrons transformed from one polarization direction to the other polarization direction by applying the same polarization strength (same polarization angle or along the same polarization axis) to both entangled electrons, they will either remain in their original entangled modes (stay Up to Up and Down to Down) or change to counter entangled modes (flip from Up to Down and Down to Up), subject to the polarization strength no matter of time and location. This phenomenon is named "Field Dependent Corresponding Entanglement". It is one of the key mysteries in physics which has been misinterpreted as coexisting quantum superposition and free will quantum entanglement (without Hidden Variables), the main reasons cause local realism conflicts in quantum mechanics.
An entangled electron pair not only has predetermined quantum energy states as Hidden Variables at the time of formation but also gives field dependent corresponding response under the same polarization strength (same polarization angle or along the same polarization axis) no matter of time and location. As a result, quantum superposition doesn't exist and quantum entanglement is predetermined. After all Einstein's Hidden Variables do exist and God doesn't play dice with the universe at all.
[Keywords]
Quantum Entanglement, Quantum Superposition, EPR Paradox, Bell's Inequality, Hidden Variables, Electron Spin, Photon Spin, Optical Polarization, Magnetic Polarization.

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I. Introduction

Many Bell's Inequality experiments including the one received 2022 Nobel Prize in physics were attempted to prove that Bell's Inequalities cannot fulfill the experimental results, such that Einstein's Hidden Variables couldn't exist and quantum superposition and quantum entanglement are true. However, in photon multiple polarization experiments, because the data are taken from mixed sample spaces which opposes to the fundamental principle of Set Theory, the base of Bell's Inequality, therefore they can't be used to calculate

Bell's Inequalities and to disapprove Hidden Variables. On the other hand, in electron entanglement experiments, because the Bell Inequalities applied are in lack of probability of polarization transformation and the experiments used have a variety of loopholes, therefore many faults are found in the analyses. As a result, the conclusions of Bell's Inequality Experiments are incomplete.

Based on Yangton and Yington Theory, quantum energy states generated by the spinning of photon and electron are proposed as the Hidden Variables. To prove the existence of these Hidden Variables, instead of the indirect proves by the confusing and complicated Bell's Inequality, a direct proves by actual experiments can be applied. Subject to the spin model and transformation mechanism of photon and electron, threshold energy of polarization transformation can be derived, which should be equal to the probability of polarization transformation and as is the measured ratio of polarization transformation. This correlation can be proved by experiments, which confirms that quantum energy states are the Hidden Variables. In addition, complying with probability of transformation, a quantum entanglement experiment with two detectors and three polarizers is studied. Again, the agreement between the calculated probability of polarization transformation and the measured ratio of polarization transformation for mixed patterns confirms that quantum energy states are indeed the Hidden Variables. It is the purpose of this paper to give a reasonable proves and sound explanation to why quantum energy states are Hidden Variables.

II. Quantum Superposition

Quantum Superposition is a fundamental principle of quantum mechanics. Any two (or more) quantum energy states can be added together ("superimposed") and the result will be another valid quantum energy state; and conversely, that every quantum energy 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 energy states, spin up and spin down, in Schrödinger equation.

III. 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 energy 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.

IV. Quantum Paradoxes

According to Quantum Superposition, scientists believe that two quantum energy states can co-exist or alter-exist in an electron. Also, Complementarity must apply to quantum energy states at time of observation. Therefore two paradoxes are raised as follows:

In case two quantum energy states co-exist in an electron, then there are two pairs of entangled states between the two electrons (?). When one electron is under observation, because of the entanglement, instant communication at infinite distance with a speed faster than light speed is needed for immediate observation of the other electron, otherwise according to quantum superposition, there is a 50% chance that the other electron will fail to show the entanglement correlation. These oppose to local realism and the speed limit principle proposed by Einstein's Special Relativity that nothing can travel faster than light speed.

In case two alternative quantum energy states exist in an electron, then constant communication between two electrons is necessary to maintain quantum entanglement. Furthermore, when one electron is under observation, instant communication at infinite distance with a speed faster than light speed is needed for immediate observation of the other electron. These again oppose to local realism and the limit of light speed proposed by Einstein's Special Relativity.

V. EPR Paradox

In 1935, Albert Einstein, Boris Podolsky, and Nathan Rosen brought up EPR Paradox [1], 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.

VI. 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" [2]. 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. However, what are those predetermined "Hidden Variables" remains a mystery.

Based on Yangton and Yington Theory, quantum energy states generated by the spinning of photon and electron can be considered as the Hidden Variables. To prove the existence of these Hidden Variables, instead of the indirect proves by confusing and complicated Bell's Inequality, a direct proves of experiment can be applied. Subject to the spin model and transformation mechanism of photon and electron, threshold energy of polarization transformation can be derived, which should be equal to the probability of polarization transformation and as is the measured ratio of polarization transformation. This correlation can be proved by experiments such that quantum energy states are Hidden Variables can be confirmed.

VII. Bell's Inequality

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 [3]. 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. However, because of the wrong mathematics used in the Bell's Inequality analyses, and the loopholes found in the experiments, the conclusions of Bell's Inequality Experiments are incomplete.

VIII. Electron Spin, Polarization and Entanglement

A. Electron Spin

According to Yangton and Yington Theory, electron has a ball structure which is composed of an outer shell (a cluster of circulating Yingtons) and an inner core (a cluster of rotating Yangtons) [4]. It is proposed when electron spins, they can move either in the same directions or the opposite directions. This phenomenon is named "Dual Spins" [5]. In Dual Spin System, there are two major categories: "Up Spin" and "Down Spin". Up means revolution direction of Yington Shell and rotation direction of Yington particle are the same direction, and Down means they are opposite directions. 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. 1).

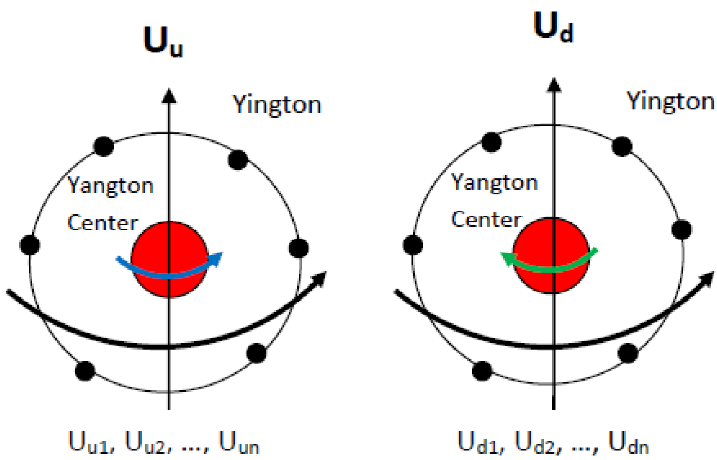

Fig. 1 Electron Spin contains Four Modes: (1) Up Spin: UP-UP (U_u) and UP-Down (U_d) modes, (2) Down Spin: Down-Down (D_d) and Dow-Up (D_u) modes. Each mode contains equal amount of energy states.

B. Quantum Energy States

Subject to the difference of the angular momentums between Yington Shell and Yangton Core, there are a number of quantum energy states in each of the spin modes. Quantum energy 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, an electron can only occupy one quantum energy state at a time, therefore a pair of entangled electrons should have quantum energy states of the same energy but opposite spin modes such as U_u5 and D_d5. Furthermore, all spin modes shall have equal amounts of quantum energy 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 energy states rather than the high energy quantum energy states. These quantum energy states generated by the spinning of electron can be considered as the predetermined Hidden Variables in electrons. Accordingly, probability of polarization transformation can be calculated which should be equal to the ratio of polarization transformation measured by experiments. The confirmation of experiment to calculation can prove that Hidden Variables indeed exist, also quantum Superposition is false and Quantum Entanglement is predetermined.

C. Polarization 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. 2 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.

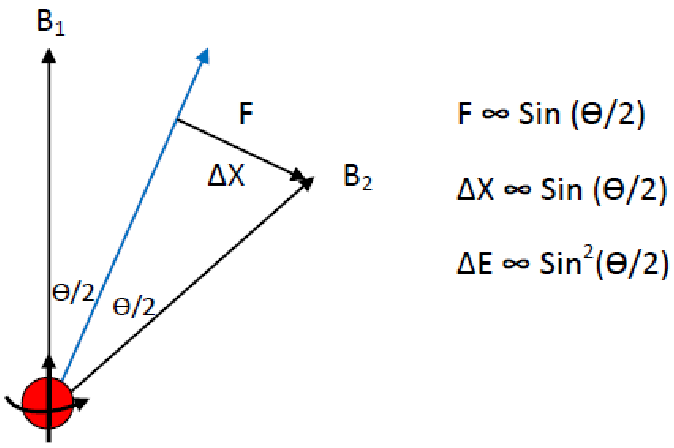

Fig. 2 Force and energy applied on an electron to change its spin direction in the transformation process (measurement).

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

Because

$F = B_2 \mathrm{Sin}(\Theta/2)$

$dX = d(L(\mathrm{Sin}(\Theta/2))) = L\,\mathrm{Cos}(\Theta/2)\, d(\Theta/2)$

$dE = FdX = B_2L\,(\mathrm{Sin}(\Theta/2)\,\mathrm{Cos}(\Theta/2))\, d\Theta$

$E = \int dE = \int B_2L\,(\mathrm{Sin}(\Theta/2)\,\mathrm{Cos}(\Theta/2))\, d\Theta$

Integrate from 0^o to Θ

$E = B_2L\,\mathrm{Sin}^2(\Theta/2)$

Therefore,

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

In Up-Down mode, the highest energy quantum energy state is EU_dn (Fig. 3). Any quantum energy state has higher energy than EU_dn will be transformed to Down-Up mode in the new direction, therefore,

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

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

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

At $\Theta = 90^o$, all quantum energy states in Up-Down mode will be transformed to the Down-Up Mode in the new direction,

$E_m(90^o) = ½\, E_{Ud}n$

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

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

$$K = E_{Ud}n$$

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

And

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

Therefore,

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

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

Because all the quantum energy states below E_m (Θ) will still remain in the same modes after transformation, therefore, the probability to find spin up mode in the new polarization direction can be represented as follows:

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

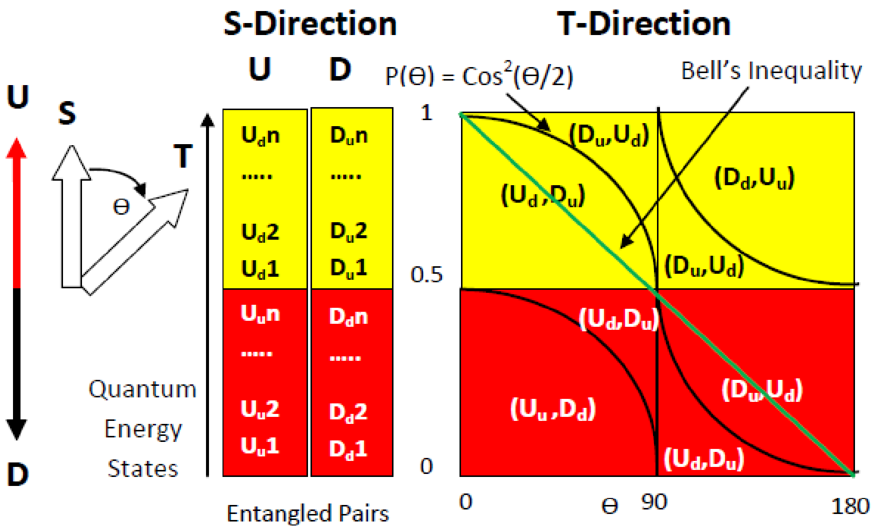

Fig. 3 Electron Polarization Transformation Diagram: The transformation Diagram of Entangled Electron pairs from S direction to T direction.

Fig. 3 shows a detailed diagram of electron polarization transformation which can be obtained by mathematics [5]. Subject to the polarization angle, entangled electron pairs in S direction can be transformed to T direction in different entangled modes from 0^o to 180^o (the maximum angle between two directions in space). For example, a pair of entangled electrons in S polarization direction has the same energy but opposite spins (U_dx, D_ux). In case their energy are higher than the threshold energy $E_m(\Theta) = Cos^2(\Theta/2)\, E_{Ud}n$, then they will gain polarization energy $\Delta E(\Theta) = Sin^2(\Theta/2)\, E_{Ud}n$ to overcome $E_{Ud}n$ and flip over their spin modes to (D_uy, U_dy). Or otherwise, if their energy is lower than the threshold energy, then they will stay at the same modes (U_dz, D_uz) after transformation.
As a result, the probability of finding the entangled electrons maintaining their original spin modes in the new polarization direction 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 in the new polarization direction after the transformation process is $1 - P(\Theta) = Sin^2(\Theta/2)$. Fig. 3 is named "Electron Polarization Transformation Diagram" [6].

D. Electron Entanglement and Polarization Transformation

Entangled electron pair occupies predetermined quantum energy states (Hidden Variables) of the same energy but opposite spin directions. While transforming from one polarization direction to the other polarization direction by applying the same polarization strength (same polarization angle or along the same polarization axis) to both entangled electrons, they will both either remain in their original entangled modes (stay Up to Up and Down to Down) or change to counter entangled modes (flip from Up to Down and Down to Up), subject to the polarization strength no matter of time and location. This phenomenon is named "Field Dependent Corresponding Entanglement". It is one of the key mysteries in physics which has been misinterpreted as coexisting quantum superposition and free will quantum entanglement (without Hidden Variables), the main reasons cause local realism conflicts in quantum mechanics.
As a result, an entangled electron pair not only has predetermined quantum energy states as Hidden Variables at the time of formation but also gives field dependent corresponding response under the same polarization strength (same polarization angle or along the same polarization axis) no matter of time and location.

IX. Photon Spin, 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 – 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) [7]. In ARRS, there are two major spin modes: "Up Spin" – photon and Yangton spin in the same direction and "Down Spin" – photon and Yangton spin in the opposite directions (Fig. 4).

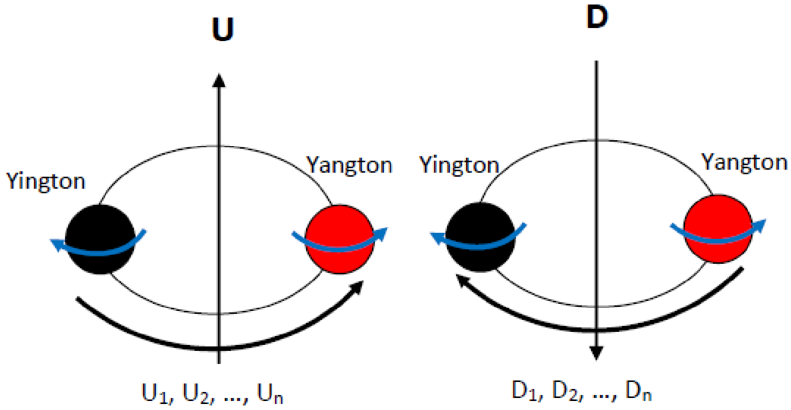

Fig. 4 Photon Spin contains two Modes: (1) Up Spin (2) Down Spin. Each mode contains equal amount of energy states.

B. Quantum Energy States

Subject to the difference of the angular momentums between Yangton and Yington, there are a number of quantum energy states in each of the spin modes. Each quantum energy state can be represented by a composite code, for example U5 means the 5th energy level of Up Mode. According to Pauli Exclusion Principle, a photon can only occupy one quantum energy state at a time, therefore a pair of entangled photons should have quantum energy states of the same energy but opposite spin modes such as U5 and D5. Furthermore, both spin up and spin down modes shall have equal amounts of quantum energy states. Also, all photons prefer to stay in the low energy quantum energy states rather than the high energy quantum energy states. These quantum energy states generated by the spinning of photon can be considered as the predetermined Hidden Variables in photons. Accordingly, probability of polarization transformation can be calculated which should be equal to the ratio of polarization transformation measured by experiments. The confirmation of experiment to calculation can prove that Hidden Variables indeed exist, also quantum Superposition is false and Quantum Entanglement is predetermined.

C. Polarization Transformation

When photon passes a polarizer, it has to overcome a corresponding energy barrier generated between the two polarization fields. Fig. 5 shows a photon transformed between two polarization fields, where B_1 is photon's original polarization field, B_2 is photon's new polarization field and Θ is the angel between B_1 and B_2.

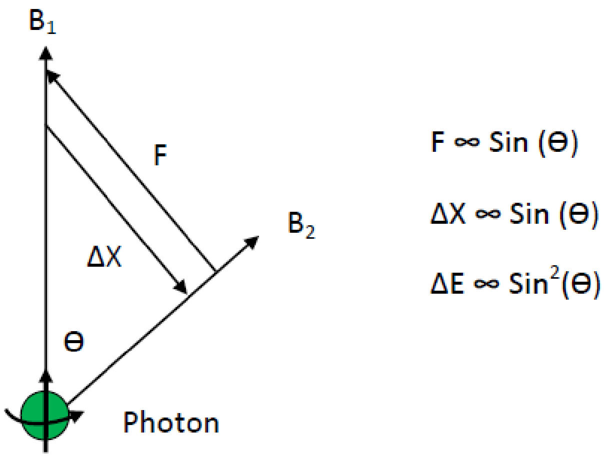

Fig. 5 Force and energy applied from a photon to change its original spin direction to a new polarization direction.

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 initial polarization force of the photon and L is the wavelength of the photon. Since the external force and displacement are in the opposite directions, ΔE is a negative energy which is the energy reduced from photon through polarization process.

Because

F = B Sin (Θ)

ΔX = L Sin (Θ)

ΔE = F ΔX

Therefore,

$$\Delta E = BL\ Sin^2(\Theta)$$

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

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

$$E_m(\Theta) = K\ Sin^2(\Theta)$$

Where $E_m(\Theta)$ is the threshold energy which is equal to ΔE(Θ) 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 pass through the polarizer.

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 (pass through the polarizer), therefore,

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

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

$$K = E_{Un}$$

Because

$E_m(\Theta) = K\ Sin^2(\Theta)$

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

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

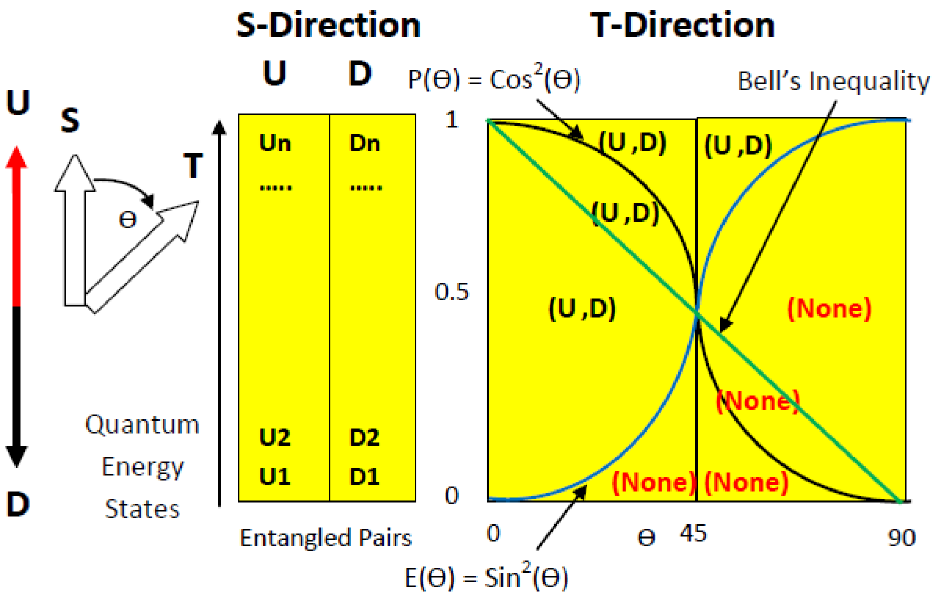

Fig. 6 Photon Polarization Transformation Diagram: The Transformation Diagram of Entangled Photon pairs from S direction to T direction.

Revised from my previous publication [7], Fig. 6 shows a detailed diagram of photon polarization transformation. Subject to the polarization angle, entangled photon pairs in S direction can be transformed to T direction in different entangled modes from 0^o to 90^o (the maximum angle between two planes in space). For example, a pair of entangled photons in S polarization direction has the same energy but opposite spins (U_x, D_x). In case their energy are higher than the energy barrier $\Delta E(\Theta) = Sin^2(\Theta)\ E_{Un}$, then they will overcome the barrier and transfer to T polarization direction remaining at the same modes (U_y, D_y). Or otherwise, they will be blocked by the energy barrier and cannot pass through the T polarizer.
As a result, the probability of finding the entangled photons maintaining their original spin modes in the new polarization direction after the transformation process (measured at angle Θ) is $P(\Theta) = Cos^2(\Theta)$. Fig. 6 is named "Photon Polarization Transformation Diagram" [6].

D. Photon Entanglement and Polarization Transformation
Entangled photon pair occupies predetermined quantum energy states (Hidden Variables) of the same energy but opposite spin directions. While transforming from one polarization direction to the other polarization direction by applying the same polarization strength (same polarization angle or along the same polarization axis) to both entangled photons, they will either both pass through the polarizer and remain in their original entangled modes (stay Up to Up and Down to Down) by overcoming the energy barrier, or both don't pass through and are blocked by the energy barrier, subject to the polarization strength no matter of time and location. This phenomenon is named "Field Dependent Corresponding Entanglement". It is one of the key mysteries in physics which has been misinterpreted as coexisting quantum superposition and free will quantum entanglement (without Hidden Variables), the main reasons cause local realism conflicts in quantum mechanics.
As a result, an entangled photon pair not only has predetermined quantum energy states as Hidden Variables at the time of formation but also gives field dependent corresponding response under the same polarization strength (same polarization angle or along the same polarization axis) no matter of time and location.

X. Bell's Inequality and Set Theory

Bell's Inequality is a mathematical theory based on Set Theory [8] as illustrated in Fig. 7. Bell's Inequality is true only if all the elements in the sets are from the same sample space and have predetermined variables.

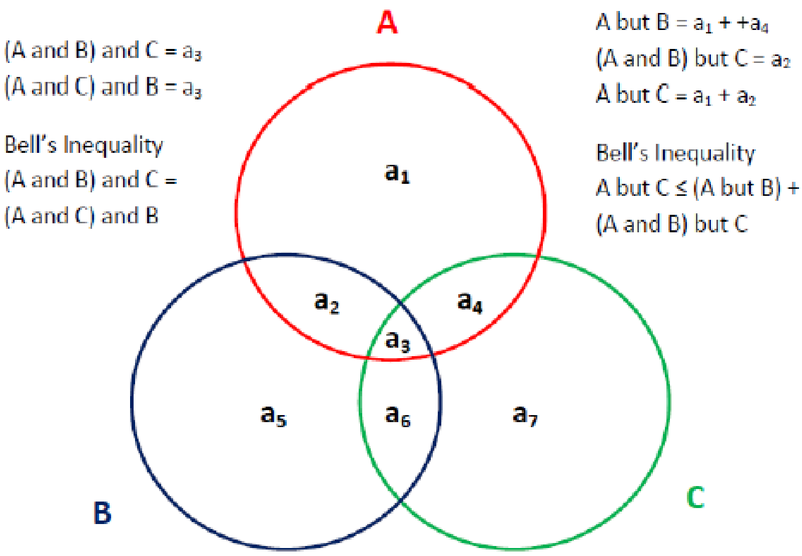

Fig. 7 Bell's Inequality and Set Theory.

XI. Bell's Inequality Experiments

To prove the existence of Hidden Variables is a big challenge. According to Bell's Inequality Theorem based on Set Theory, every set of photons and electrons with Hidden Variables (quantum energy states) in the same sample space should obey Bell's Inequalities. Therefore, if there is just one set of photons or electrons that don't satisfy Bell's Inequality, it can be used to prove that Hidden Variables don't exist. Because of this reason, a variety of experiments were designed and carried out by different scientists, trying to prove that there exists one set of photons or electrons that doesn't obey Bell's Inequality. Those experiments can be classified into two categories: photon multiple polarization experiments and electron entanglement experiments. But both experiments have loopholes. On one hand, in photon multiple polarization experiments, both mathematical and experimental data are chosen from mixed sample spaces which oppose to Set Theory. On the other hand, in electron entanglement experiments, because the Bell Inequalities used are in lack of probability of polarization transformation and the experiments practiced have many loopholes. Therefore, all Bell's Inequality Experiments are in vain.

XII. Photon Multiple Polarization Experiment

A typical photon multiple polarization experiment can be carried out by passing a light beam through three polarizers with polarization angles A = 0^o, B = 22.5^o and C = 45^o. The intensity of the transmitted light is listed in Table 1 [6], where "Real Transmission" is the actual measurement results and "Bell Transmission" is the theoretical Bell's Inequality. Because Real Transmission results don't match with Bell Transmission, therefore it is claimed that Hidden Variables don't exist and such that Superposition Theory and Complementarity Principle must be true. However, there is a big loophole in this conclusion. In the experiment, energy is first reduced from photons to create "Field Dependent Hidden Variables" [9] during the first polarization process, and then further normalized to form "Normalized Field Dependent Hidden Variables" [9] in the subsequent polarization process. In other words, the elements (photons with hidden variables) used in the calculation of Bell's Inequality are taken from mixed sample spaces instead of the same one which opposes to the basic principle of Set Theory. Therefore, all efforts in photon multiple polarization experiments using Bell's Inequality to prove that Hidden Variables don't exist are in vain [10][11].

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

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

XIII. Electron Entanglement Experiments

According to Set Theory, in the same sample space, all sets containing elements with hidden variables should fulfill Bell's Inequalities. Therefore, besides the Photon Multiple Polarization Experiments of mixed sample spaces, the whole purpose of Electron Entanglement Experiments is trying to find one exception in the same sample space that doesn't meet with Bell's Inequality, so as to prove Hidden Variables don't exist.

In Electron Entanglement Experiments, all elements (entangled electrons with quantum energy states – Hidden Variables) are coming from the same sample space generated by an electron source. Polarizer is used to form a spin up set (a group of elements with quantum energy states under the threshold energy dependent on the polarization angle), and a spin down set (a group of elements with quantum energy states above the threshold energy). In theory, because all those sets generated by different polarizers contain elements (entangled electrons with Hidden Variables) from the same Hidden Variables Sample Space, Bell's Inequality should always hold for all of them. However, in reality, because of the inevitable system loopholes in the experiments, and the lack of probability of polarization transformation in Bell's Inequalities, experimental results do not fulfill Bell's Inequality which results in a big misunderstanding and confusion such as simultaneously coexisting quantum superposition and free will quantum entanglement.

Based on Yangton and Yington Theory, quantum energy states generated by the spinning of electron are proposed as the Hidden Variables. To prove the existence of these Hidden Variables, instead of the indirect proves by the confusing and complicated Bell's Inequality, a direct proves by actual experiments is applied. Subject to the spin model and transformation mechanism of electron, threshold energy of transformation can be derived, which should be equal to the probability of polarization transformation and as is the measured ratio of polarization transformation. Since these correlations can be proved by experiments, therefore it is concluded that quantum energy states are Hidden Variables and they do exist in every electrons.

In addition, complying with probability of polarization transformation, a specific quantum entanglement experiment (named Alice and Bob Experiment) with two detectors and two identical sets of three polarizers is studied. Again, the agreement between the calculated probability of polarization transformation and the measured ratio of polarization transformation for mixed patterns confirms that quantum energy states are the Hidden Variables. A detailed analysis of this experiment is discussed.

A. Prove by Bell's Inequality (Indirect Prove)

There are two key components in Bell's Inequality Experiments: Mathematics which is calculated by a Bell's Inequality Theorem, and Experiment which is determined by a testing system. Clauser pointed out there are always some system limitations and loopholes that can affect the experimental results [12]. On the other hand, Brian Greene reviewed Alice and Bob Experiment and concluded that because experimental results don't agree with Bell's Inequality, therefore Hidden Variables couldn't exist and thus quantum superposition and quantum entanglement must be true [13]. However, in Greene's analysis, a Bell Inequality Theorem in lack of probability of polarization transformation was used which leads to wrong conclusions. For example, as shown in Fig 8 and Table 2, with probability of polarization transformation, a spin up electron passes through 120^o polarizer in Alice's laboratory, there is 25% chance to be detected as spin up electrons. Accordingly the entangled spin down electron passes through the same 120^o polarizer in Bob's laboratory, there is 25% chance to be spin down. These results are different from Greene's analysis, in which without probability of polarization transformation, it is always assumed 100% spin up for the entangled electron detected in Alice's laboratory and 100% spin down for the other entangled electron detected in Bob's laboratory, or vise versa. Because of these mistakes, prove of nonexistence of Hidden Variables by Bell's Inequality is incomplete.

B. Prove by Probability of Polarization Transformation (Direct Prove)

In Alice and Bob Experiment, 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^o 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 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, and 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 ($P_1=\Phi+180^o$, $P_2=\Phi+300^o$, $P_3=\Phi+60^o$). In either case, predicted by mathematics with probability of polarization transformation, the chance of finding opposite spins in two laboratories is always 50%, which can be proved by experiments (Also, 50% is a generic assumption by quantum superposition theory).

1. Coherent electrons measured by three polarizers in the same laboratory

Because the probability to find the same spin as that of the electron passing through a magnetic polarizer at angle Θ is $\cos^2(\Theta/2)$ (Fig. 3), where Θ is the angle between the magnetic polarization directions of the electron and the magnetic polarizer. Therefore, the total probabilities $P(\Phi)$ to find the same spin as the electron from a coherent electron source passing through either one of the three polarizers (Φ, $\Phi+120^o$, $\Phi+240^o$) (Fig. 8) can be calculated as follows:

$P(\Phi) = [\cos^2(\Phi/2) + \cos^2(\Phi/2 + 120^o/2) + \cos^2(\Phi/2 + 240^o/2)]/3$

Because

$\cos(\Theta+\Phi) = \cos\Theta \cos\Phi - \sin\Theta \sin\Phi$

Therefore,

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

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

2. Random electrons measured by three polarizers in the same laboratory

The probability to find the same spin as the 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,

$P = 1/2\pi \int 1/3[\cos^2(\Phi/2) + \cos^2(\Phi/2 + 120^o/2) + \cos^2(\Phi/2 + 240^o/2)]\, d\Phi$

$$P = 50\%$$

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

3. Entangled electrons measured by identical set of three polarizers in two laboratories

Assuming Bob using the same set of three magnetic polarizers as Alice, then two cases are studied here: Case A ($\Phi = 0^o$), where the polarization direction of the 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 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 electron "e" coming to Alice's laboratory, then Fig. 8 shows the probabilities of finding spin up electrons in the polarization direction of either of the three magnetic polarizers in Alice's laboratory (the electron "e" coming to Alice's laboratory is spin up) and the probability of finding spin up electrons in the polarization direction of either of the three magnetic polarizers in Bob's laboratory (because of the entanglement, the 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.

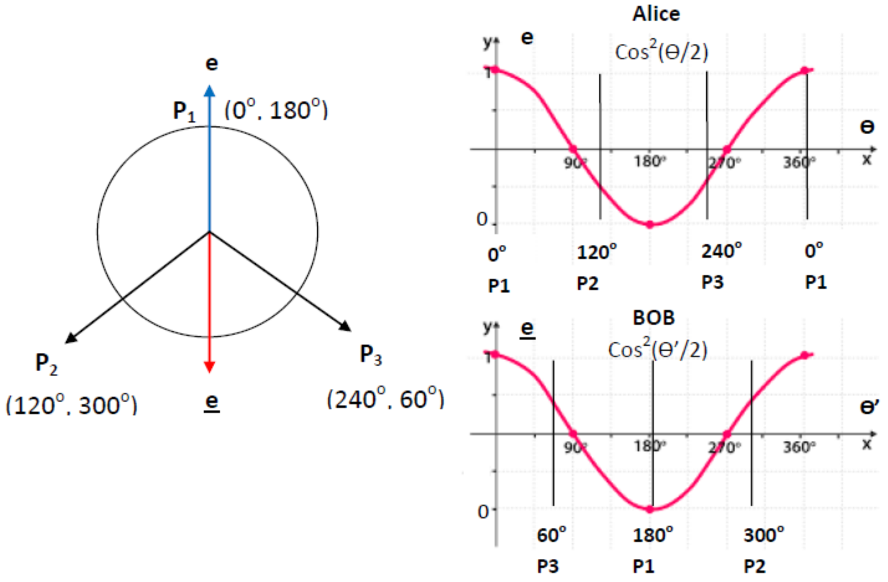

Fig. 8 The possibilities of spin up at Alice's and spin down at Bob's laboratories, Θ is the angel from e and Θ' is the angel from e (at Φ = 0°, Φ is the angle between electron e (spin up) and P_1 at Alice's laboratory).

Table 2 shows the probabilities 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 probability of finding spin up in Alice's laboratory and spin down in Bob's laboratory, and P_D is the probability of finding spin down in Alice's laboratory and spin up in Bob's laboratory.

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

For example, with P_2P_3 combination (Alice uses P_2 magnetic polarizer and Bob uses P_3 magnetic polarizer),
$P_U = Cos^2(120^o/2)\ [1-Cos^2(60^o/2)] = (1/2)^2\ [1-(3^{1/2}/2)^2] = 1/16$
$P_D = [1- Cos^2(120^o/2)]\ Cos^2(60^o/2) = (3/4)\ (3/4) = 9/16$
$P_U + P_D = 10/16$
Therefore, the total probability P of finding opposite spins between Alice and Bob can be calculated as follows:
$P = 1/9\ \Sigma(P_U + P_D) = 1/9\ (1 + ¼ + ¼ + ¼ + 10/16 + 10/16 + ¼+ 10/16 + 10/16)$
P = 50%
As a result, in case the polarization direction of the electron coming to Alice's laboratory is the same as P_1 magnetic polarizer ($\Phi = 0^o$), then the total probability of finding opposite spins between Alice and Bob is 50%, and the total probability of finding the same spins is also 50%. (Note: The above results are revised from the

previous publication [11] in which the spin up and spin down probabilities in Bob's laboratory were mistakenly switched).

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

In case the polarization direction of P_1 magnetic polarizer is opposite ($\Phi = 180^o$) to the electron "e" coming to Alice's laboratory, then Fig. 9 shows the probabilities of finding spin up electrons in the polarization direction of either of the three magnetic polarizers in Alice's laboratory (the electron "e" coming to Alice laboratory is spin up) and the probability of finding spin up electrons in the polarization direction of either of the three magnetic polarizers in Bob's laboratory (because of the entanglement, the electron "<u>e</u>" 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 "<u>e</u>" in Bob's laboratory.

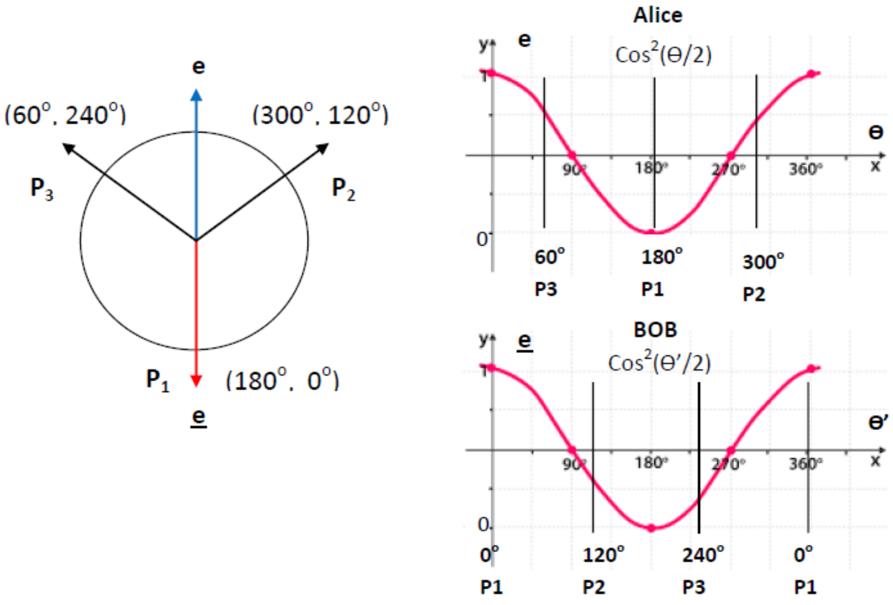

Fig. 9 The possibilities of spin up at Alice's and spin down at Bob's laboratories, Θ is the angel from e and Θ' is the angel from <u>e</u> (at $\Phi = 180^o$, Φ is the angle between the original electron e (spin up) and P_1 at Alice's laboratory).

Table 3 shows the probabilities 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 probability of finding spin up in Alice's laboratory and spin down in Bob's laboratory, and P_D is the probability of finding spin down in Alice's laboratory and spin up in Bob's laboratory.

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	$Cos^2(180°/2)$	$1- Cos^2(0°/2)$	0	$1- Cos^2(180°/2)$	$Cos^2(0°/2)$	1	1
P_1P_2	$Cos^2(180°/2)$	$1-Cos^2(120°/2)$	0	$1- Cos^2(180°/2)$	$Cos^2(120°/2)$	1/4	1/4
P_1P_3	$Cos^2(180°/2)$	$1-Cos^2(240°/2)$	0	$1- Cos^2(180°/2)$	$Cos^2(240°/2)$	1/4	1/4
P_2P_1	$Cos^2(300°/2)$	$1-Cos^2(0°/2)$	0	$1- Cos^2(300°/2)$	$Cos^2(0°/2)$	1/4	1/4
P_2P_2	$Cos^2(300°/2)$	$1-Cos^2(120°/2)$	9/16	$1- Cos^2(300°/2)$	$Cos^2(120°/2)$	1/16	10/16
P_2P_3	$Cos^2(300°/2)$	$1-Cos^2(240°/2)$	9/16	$1- Cos^2(300°/2)$	$Cos^2(240°/2)$	1/16	10/16
P_3P_1	$Cos^2(60°/2)$	$1-Cos^2(0°/2)$	0	$1- Cos^2(60°/2)$	$Cos^2(0°/2)$	1/4	1/4
P_3P_2	$Cos^2(60°/2)$	$1-Cos^2(120°/2)$	9/16	$1- Cos^2(60°/2)$	$Cos^2(120°/2)$	1/16	10/16
P_3P_3	$Cos^2(60°/2)$	$1-Cos^2(240°/2)$	9/16	$1- Cos^2(60°/2)$	$Cos^2(240°/2)$	1/16	10/16

$P = 1/9\ \Sigma(P_U + P_D) = 1/9\ (1 + ¼ + ¼ + ¼ + 10/16 + 10/16 + ¼+ 10/16 + 10/16)$
$P = 50\%$
Where P is the total probability of finding opposite spins between Alice's and Bob's laboratories.
As a result, in case the polarization direction of P_1 polarizer is opposite (180°) to the electron coming to Alice's laboratory, the total probability of finding mixed spins between Alice and Bob is 50%, and the total probability of finding the same spins is also 50%. (Note: The above results are revised from previous publication [11] in which the spin up and spin down probabilities in Bob's laboratory were mistakenly switched). Furthermore, the same results can be obtained for the electrons coming to Alice's laboratory at different angels from 0° to 180°.

C. Proved by Bell's Inequality with Probability of Polarization Transformation

In Alice and Bob Experiments [13], for each pair of entangled electrons passing through the same polarizers in both laboratories, 100% spin up in Alice laboratory and 100% spin down in Bob laboratory, or vice versa, are assumed for Bell's Inequality calculations, instead of the actual probability of polarization transformation $Cos^2(\Theta/2)$ of spin up and $Sin^2(\Theta/2)$ of spin down. Because of these mistakes, the conclusion "Hidden Variables don't exist because of the mismatch between experimental results and Bell's Inequalities" is totally false. In fact, with the correct probability of polarization transformation, all experimental results should fulfill Bell's Inequalities.

Furthermore, in Alice and Bob Experiments, for any symmetrical polarizers such as 0°, 120° and 240° with a pattern of 50% chance appearance such as one out of two (spin up or spin down for a polarizer) or two out of four (mixed spins for two polarizers), the total probability of getting the same patterns or mixed patterns is always 50%. But, this is not true for asymmetrical polarizers. For example, with two asymmetric polarizers 120° (P_2) and 240° (P_3), the total probability of finding mixed patters (spin up in Alice laboratory and spin down in Bob's laboratory, or vice versa) can be calculated according to Table 2 as follows:
$P_2P_2 = 1/16 + 9/16 = 10/16$
$P_2P_3 = 1/16 + 9/16 = 10/16$
$P_3P_2 = 1/16 + 9/16 = 10/16$
$P_3P_3 = 1/16 + 9/16 = 10/16$
Total = (10/16 +10/16 +10/16 +10/16)/4 = 10/16 = 62.5%
Therefore, the total probability of finding mixed patterns with 120° and 240° polarizers should be 62.5% instead of the generic 50% predicted by quantum superposition theory.

XIV. Conclusion

Most Bell's Inequality experiments including the one received 2022 Nobel Prize in physics were attempted to prove that Bell's Inequalities cannot fulfill the experimental results, such that Einstein's Hidden Variables couldn't exist and quantum superposition and quantum entanglement are true. However, in photon multiple polarization experiments, because the data are taken from mixed sample spaces which opposes to the fundamental principle of Set Theory, the base of Bell's Inequality, therefore they can't be used to calculate Bell's Inequalities and to disapprove Hidden Variables. On the other hand, in electron entanglement experiments, because the Bell Inequalities applied are in lack of probability of polarization transformation and the experiments used have a variety of loopholes, therefore many faults are found in the analyses. As a result, the conclusions of Bell's Inequality Experiments are incomplete.

Based on Yangton and Yington Theory, quantum energy states generated by the spinning of photon and electron are proposed as the Hidden Variables. To prove the existence of these Hidden Variables, instead of the indirect proves by the confusing and complicated Bell's Inequality, a direct proves by actual experiments can be applied. Subject to the spin model and transformation mechanism of photon and electron, threshold energy of polarization transformation can be derived, which should be equal to the probability of polarization transformation and as is the measured ratio of polarization transformation. This correlation can be proved by experiments, which confirms that quantum energy states are the Hidden Variables. In addition, complying with probability of transformation, a quantum entanglement experiment with two detectors and three polarizers is studied. Again, the agreement between the calculated probability of polarization transformation and the measured ratio of polarization transformation for mixed patterns confirms that quantum energy states are indeed the Hidden Variables.

Furthermore, when a pair of entangled electrons transformed from one polarization direction to the other polarization direction by applying the same polarization strength (same polarization angle or along the same polarization axis) to both entangled electrons, they will either remain in their original entangled modes (stay Up to Up and Down to Down) or change to counter entangled modes (flip from Up to Down and Down to Up), subject to the polarization strength no matter of time and location. This phenomenon is named "Field Dependent Corresponding Entanglement". It is one of the key mysteries in physics which has been misinterpreted as coexisting quantum superposition and free will quantum entanglement (without Hidden Variables), the main reasons cause local realism conflicts in quantum mechanics.

An entangled electron pair not only has predetermined quantum energy states as Hidden Variables at the time of formation but also gives field dependent corresponding response under the same polarization strength (same polarization angle or along the same polarization axis) no matter of time and location. As a result, quantum superposition doesn't exist and quantum entanglement is predetermined. After all Einstein's Hidden Variables do exist and God doesn't play dice with the universe at all.

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