Quantum Entanglement is Paradoxical

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Abstract In 1925, in response to no experiment that needed explanation, the quantum theory that originated with Planck was replaced with a set of non-physical postulates.

The re-invented theory did not explain better any experiment, did not increase physical understanding, and introduced into physics the non-physical notions of mathematical functional analysis.

Unlike Planck's Quantum Mechanics that determines the most fundamental constants of physics, Planck's radiation constant h, and Planck's entropy constant k[1], the 1925 Quantum Mechanics exhibits total ignorance of h that eventually led to setting h to 1.

In that theory, a particle has infinitely many components in abstract set, Hilbert space that is unrelated to physical space, physical quantities like location and momentum are operators, and measurements may have imaginary values.

Heisenberg's Uncertainty Principle restates the trivial fact that illuminating an electron to find its location will change its

[1] which Planck named after Boltzmann

velocity, and momentum.

The representation of a particle state as an element of a Hilbert space has no physical meaning.

Neither do imaginary numbers, or operators of momentum, position, and energy.

The 1925 Quantum Mechanics postulates that for a particle moving at speed much smaller than light speed, the particle state is completely represented by Schrödinger's wave function

$$\Psi(x,t).$$

Born conjectured that the probability to find a particle at location x, at time t is

$$\left|\Psi(x,t)\right|^2$$

Einstein concluded that this statistical interpretation meant that $\Psi(x,t)$ gave an incomplete description of the quantum state. that some variables were unknown, and that adding them will complete, and correct the theory.

The 1935 EPR paper proves that $\Psi(x,t)$ for a system of two particles, allows simultaneous measurement of location, and momentum of either particle.

Thus, $\Psi(x,t)$ contradicts Heisenberg's Uncertainty Principle, and allows the impossible simultaneous determination of the location, and the speed of an electron.

This leads to the demise of the 1925 Quantum Mechanics, and the Entanglement that follows from it, and depends on it.

Quantum Entanglement is based on the 1925 Quantum Theory, and as such it is paradoxical.

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Contents

0.
Quantum Entanglement

Quantum Entanglement is the belief that the spins of two electrons generated together and moving in opposite directions may depend on each other even later when the electrons are at infinite distance from each other. And that this happens at infinite speed.

If the total spin is of the two entangled electrons is zero, and one has clockwise spin, then the other electron has anticlockwise spin.

Einstein considered this impossible, and called it "spooky action at a distance".

Believers hold that quantum entanglement was experimentally confirmed. Although no one could apply it to faster-than-light communication.

Quantum Entanglement is based on a paradoxical Quantum Theory that was postulated in 1925.
As such, Quantum Entanglement is paradoxical.

1.

The 1925 Quantum Mechanics

In 1925, in response to no experiment that needed explanation, the quantum theory was axiomatized. The new theory did not explain better any experiment, did not increase physical understanding, and introduced into physics the non-physical notions of mathematical functional analysis.

Heisenberg's Uncertainty Principle restates the trivial fact that illuminating an electron to find its location will change its velocity, and momentum.

Dirac's representation of a particle state as an element of a Hilbert space has no physical meaning.

The 1925 Quantum Mechanics postulates that for a particle moving at speed much smaller than light speed, the particle state is completely represented by Schrödinger's wave function

$$\Psi(x,t).$$

For a particle with mass m, at location x, and at time t, $\Psi(x,t)$ satisfies the Schrödinger's wave equation

$$\frac{1}{2m}(\frac{h}{2\pi})^2\partial_x^2\Psi(x,t)+V(x)\Psi(x,t)=i\frac{h}{2\pi}\partial_t\Psi(x,t).$$

Unlike De-Broglie matter waves, $\Psi(x,t)$ can have non-physical imaginary and complex values.

Born conjectured that the probability to find a particle at location x, at time t is

$$\left|\Psi(x,t)\right|^2$$

Einstein concluded that having statistical interpretation meant that $\Psi(x,t)$ gave an incomplete description of the quantum state. that some variables were unknown, and that adding them will complete, and correct the theory.

The 1935 EPR paper proves that $\Psi(x,t)$ for a system of two particles, allows simultaneous measurement of location, and momentum of either particle.

Thus, $\Psi(x,t)$ contradicts the Uncertainty Principle of the 1925 Theory, and allows the impossible simultaneous determination of the location, and the speed of an electron.

This leads to the demise of the 1925 Quantum Mechanics, and the Entanglement that follows from it, and depends on it.

2.
The 1925 Quantum Mechanics of One Particle

At time t, a particle moving along the q axis has momentum

$$p = p(t)$$

at the location

$$q = q(t).$$

Axiomatic Quantum Mechanics postulates that the particle state is completely represented by the wave function

$$\psi(p,q) = e^{\frac{2\pi i}{h} p_0 q}$$

where

$$h = \text{planck constant},$$

and

$$p_0 = \text{ constant number}.$$

$\psi(p,q)$ is an eigen-function of the momentum operator

$$P = \frac{h}{2\pi i}\partial_q,$$

with the eigen-value p_0 because

$$P\psi = \frac{h}{2\pi i}\partial_q\left\{e^{\frac{2\pi i}{h}p_0 q}\right\},$$

$$= \underbrace{\frac{h}{2\pi i}\frac{2\pi i}{h}}_{1} p_0 \underbrace{e^{\frac{2\pi i}{h}p_0 q}}_{\psi},$$

$$= p_0\psi.$$

Therefore, at the state given by $\psi(p,q)$, the particle's momentum is

$$p(t)\Big|_{\psi(p,q)} = p_0$$

But $\psi(p,q)$ is not an eigen function of the location operator

$$Q = q(t)$$

because

$$Q\psi = q(t)e^{\frac{2\pi i}{h}p_0 q},$$

and the variable $q(t)$ is not a constant number, and not an eigen-value.

Therefore, at the state given by $\psi(p,q)$, the particle's location

$$q(t)\Big|_{\psi(p,q)}$$

has no definite value.

The probability that the particle's location is between a, and b is

$$\int_{q=a}^{q=b} \psi(p,q)\overline{\psi}(p,q)dq = \int_{q=a}^{q=b} \underbrace{e^{\frac{2\pi i}{h}p_0 q} e^{-\frac{2\pi i}{h}p_0 q}}_{1} dq$$

$$= b - a.$$

Thus, all locations are equally probable, and the particle may be found at any location $q(t)$.

Direct measurement of the particle's location will alter its state, demolish its wave function $\psi(p,q)$, and eliminate the knowledge of its momentum.

Therefore, when the particle's momentum is known with certainty, its location cannot be determined.

That is, the 1925 quantum mechanics of one particle is consistent with what we expect to happen in nature.

In general, it is shown in the 1925 Quantum Mechanics that since the momentum, and location operators of a quantum system do not commute,

$$PQ \neq QP,$$

then the precise knowledge of the system's momentum, precludes the knowledge of its location, and the precise knowledge of the system's location precludes the knowledge of its momentum.

We shall see that this basic property does not hold for a two particles' quantum system.

3.
The 1925 Quantum Mechanics of Two Particles

At time

$$0 \le t \le T,$$

a particle moving along the q axis with momentum

$$p_1 = p_1(t),$$

at the location

$$q_1 = q_1(t),$$

interacts with a second particle moving along the q axis with momentum

$$p_2 = p_2(t),$$

at the location

$$q_2 = q_2(t).$$

For each p, the first particle momentum operator

$$P_1 = \frac{h}{2\pi i}\partial_{q_1},$$

has the eigen functions

$$u_p(p_1, q_1) = e^{\frac{2\pi i}{h}pq_1}$$

with the eigen-value p because

$$P_1 u_p = \frac{h}{2\pi i}\partial_{q_1}\left\{e^{\frac{2\pi i}{h}pq_1}\right\},$$

$$= \underbrace{\frac{h}{2\pi i}\frac{2\pi i}{h}}_{1} p \underbrace{e^{\frac{2\pi i}{h}pq_1}}_{u_p},$$

$$= pu_p .$$

Thus, the measurement of $p_1(t)$ at $u_p(p_1, q_1)$ gives

$$p_1(t)\Big|_{u_p} = p .$$

The wave function of the two particles, $\Psi(p_1, q_1; p_2, q_2)$ can be expanded in the eigen functions u_p, with coefficients

$$\psi_p(p_2, q_2) = e^{\frac{2\pi i}{h}(-p)q_2} e^{\frac{2\pi i}{h}pp_0},$$

by integrating over the continuous spectrum of the momentum p

$$\Psi(p_1, q_1; p_2, q_2) = \int_{p=-\infty}^{p=\infty} \underbrace{u_p(p_1, q_1)}_{e^{\frac{2\pi i}{h}pq_1}} \underbrace{\psi_p(p_2, q_2)}_{e^{\frac{2\pi i}{h}(-p)q_2} e^{\frac{2\pi i}{h}pp_0}} dp ,$$

$$= \int_{p=-\infty}^{p=\infty} e^{\frac{2\pi i}{h}(q_1 - q_2 + q_0)p} dp .$$

For each p, the coefficients $\psi_p(p_2, q_2)$ are eigen functions of the second particle momentum operator

$$P_2 = \frac{h}{2\pi i}\partial_{q_2} ,$$

with the eigen-value $-p$ because

$$P_2\psi_p = \frac{h}{2\pi i}\partial_{q_2}\left\{ e^{\frac{2\pi i}{h}(-p)q_2} e^{\frac{2\pi i}{h}pp_0} \right\},$$

$$= \underbrace{\frac{h}{2\pi i}\frac{2\pi i}{h}}_{1}(-p)\underbrace{e^{\frac{2\pi i}{h}(-p)q_2} e^{\frac{2\pi i}{h}pp_0}}_{\psi_p},$$

$$= (-p)\psi_p .$$

Thus, the measurement of $p_2(t)$ at the state $\psi_p(p_2, q_2)$ gives

$$p_2(t)\Big|_{\psi_p} = -p .$$

Alternatively, for each q, the first particle location operator

$$Q_1 = q_1 ,$$

has the eigen functions

$$v_q(p_1, q_1) = \delta(q - q_1)$$

with the eigen-value q because

$$Q_1 v_q = q_1\delta(q - q_1),$$

$$= q\delta(q - q_1),$$

$$= qv_q .$$

Thus, the measurement of $q_1(t)$ at the state $v_q(p_1, q_1)$ gives

$$q_1(t)\Big|_{v_q} = q .$$

Therefore, the wave function of the two particles $\Psi(p_1, q_1; p_2, q_2)$ can be expanded also in the eigen functions v_q, with coefficients

$$\varphi_q(p_2, q_2) = h\delta(q - q_2 + q_0),$$

by integrating over the continuous spectrum of the location q

$$\Psi(p_1, q_1; p_2, q_2) = \int_{q=-\infty}^{q=\infty} \underbrace{v_q(p_1, q_1)}_{\delta(q_1 - q)} \underbrace{\varphi_q(p_2, q_2)}_{h\delta(q - q_2 + q_0)} dq$$

$$= h\delta(q_1 - q_2 + q_0).$$

Since $\delta(x) = \frac{1}{2\pi}\int_{\sigma=-\infty}^{\sigma=\infty} e^{i\sigma x} d\sigma$, $h\delta(q_1 - q_2 + q_0)$ is the wave packet

$$h\frac{1}{2\pi}\int_{\sigma=-\infty}^{\sigma=\infty} e^{i\sigma(q_1 - q_2 + q_0)} d\sigma = \int_{\sigma=-\infty}^{\sigma=\infty} e^{i\frac{2\pi}{h}(\frac{h}{2\pi}\sigma)(q_1 - q_2 + q_0)} d\underbrace{(\frac{h}{2\pi}\sigma)}_{p},$$

$$= \int_{p=-\infty}^{p=\infty} e^{\frac{2\pi i}{h}p(q_1 - q_2 + q_0)} dp.$$

For each q, the coefficients $\varphi_q(p_2, q_2)$ are eigen functions of the second particle location operator

$$Q_2 = q_2,$$

with the eigen-value $q + q_0$ because

$$Q_2\varphi_q = q_2 h\delta(q - q_2 + q_0),$$

$$= (q + q_0)h\delta(q - q_2 + q_0),$$

$$= (q + q_0)\varphi_q.$$

Thus, the measurement of $q_2(t)$ at the state $\varphi_q(p_2, q_2)$ gives

$$q_2(t)\Big|_{\varphi_q} = q + q_0.$$

After the interaction between the two particles ends, for the measurement of the momentum, the first particle is at the state $u_p(p_1, q_1)$, and the second particle is at the state $\psi_p(p_2, q_2)$.

For the measurement of the location, the first particle is at the state $v_q(p_1, q_1)$, and the second particle is at the state $\varphi_q(p_2, q_2)$.

Since the measurements are done after the interaction ends, the second particle is not affected by the first, and we can determine simultaneously the momentum, and the location of the second particle with

$\psi_p(p_2, q_2)$, an eigen function of P_2,

and

$\varphi_q(p_2, q_2)$, an eigen function of Q_2.

But P_2, and Q_2 do not commute. In fact,

$$\left(P_2 Q_2 - Q_2 P_2\right)\psi = \frac{h}{2\pi i}\partial_{q_2}\left\{q_2\psi\right\} - q_2\frac{h}{2\pi i}\partial_{q_2}\psi,$$

$$= \frac{h}{2\pi i}\left(\psi + q_2\partial_{q_2}\psi\right) - q_2\frac{h}{2\pi i}\partial_{q_2}\psi,$$

$$= \frac{h}{2\pi i}\psi.$$

Thus, the basic notion of a state represented by the Schrödinger Wave Function contradicts Heisenberg's Uncertainty Principle that when the particle's momentum is known with certainty, its location cannot be determined.

It contradicts Axiomatic Quantum Mechanics that since the momentum, and location operators of a quantum system do not commute, then the precise knowledge of the system's momentum, precludes the knowledge of its location, and the precise knowledge of the system's location precludes the knowledge of its momentum.

Thus, Schrödinger's wave function is paradoxial already for a system of two particles. the 1925 Quantum Mechanics works only for one particle, and fails when applied to a system of two particles.

4.
Bell's Theorem, and Quantum Entanglement

Bell sought an answer to the question posed by EPR whether hidden variables exist in the 1925 Quantum Mechanics.

Perhaps, he missed EPR critical finding that the 1925 Quantum Mechanics is flawed beyond repair, or perhaps he refused to accept that finding.

Over time, Schrodinger's assumption of $\Psi(x,t)$ was accepted as a fact of Physics. The simultaneous measurement of space, and time, and spin that fails the 1925 theory, seems remote from the $\Psi(x,t)$.

Thus, assuming the contradictory 1925 Quantum Mechanics, Bell proved his Bell's Theorem that tests for the existence of hidden variables. The negative answer to the existence of hidden variables allows for the conclusion of quantum entanglement in Quantum Mechanics.

Bell's Theorem that allows for the "spooky action at a distance" is in fact another proof that the 1925 Quantum Mechanics is flawed.

That is, if assuming the 1925 Theory leads to impossible entanglement. Then, the 1925 Theory is incorrect.

Instead, Bell assumed that the false 1925 Theory is correct, and was forced by this assumption to conclude that the impossible

Entanglement is correct.

The dependence of Bell's Theorem on the false Theory starts with his need to compute probabilities.

The probabilities Bell refers to are values of

$$\left|\Psi\right|^2,$$

where Ψ would be the wave function of the system if the system exists.

As shown by EPR, and elaborated here, such system does not exist. And there is no such wave function as needed for Bell's Theorem.

Consequently, Bell's Theorem is proven for a non-existing quantum mechanical system

The Entanglement holds in non-existing quantum mechanical system.

Consequently, the experiments to establish Entanglement have no theoretical basis. Until such basis for Entanglement will be established, these experiments need not be addressed.

Assuming the 1925 quantum mechanics, and $\Psi(x,t)$, the Experiments lead to entanglement, and to propagation of physical phenomena at infinite speed. This conclusion seems more plausible to the experimenters than the demise of the 1925 quantum mechanics.

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