On the Refutation of Bell's Theorem

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Abstract

Bell's theorem states that no classical theory, based on local hidden variables, can fully describe the predictions of quantum mechanics. In other words: quantum mechanics is not compatible with local hidden variable theories. This theorem is wrong. That has been demonstrated by the results of previous papers, showing the exact mechanism in Bell experiments and how that mechanism comes about. In those papers correlations in experiments are exactly explained classically. They also describe what is needed for that explanation. In this paper the results are proven by simple goniometry.

Over the past five or six years I wrote many papers about Bell experiments and the correlations that occur in those experiments. I wanted to explain those correlations classically. Although a number of attempts have been made, no one succeeded to find a proper explanation. It appeared to be no easy task. The reason why it was so difficult to find a proper explanation was that an important physical principle was missing. This is the Principle of Perspective. Like the Principle of Relativity, the Principle of Perspective is universally valid. We will talk about it in this paper.

In the papers I wrote I made a lot of assertions. Some of them may not have been fully correct and some of them may be plain wrong. I apologize for that. It has been an instructive journey full of discoveries.

I began the journey because I wanted to know more about the Universe. To that purpose I started to read books on physics. I read dozens of books. I learned that physics rests on two major theories: General Relativity Theory and Quantum Theory. Both theories are equally accepted concerning their validity. Relativity Theory seems rather straight-forward while Quantum Theory raises more questions. The mathematics of Quantum Theory is very difficult and much of the discussion is about the interpretation of that mathematics, especially the meaning of the wavefunction. Even Einstein and Bohr debated on it. The mathematics of Quantum Theory seemed to imply that elementary particles could be in a state of 'superposition', meaning that they could be in different states at the same time. And that particles can be 'entangled', meaning that there can be instantaneous interaction at a distance between them. To Einstein this was impossible. Bohr, on the other hand, seemed to have stated that if one cannot know the properties of particles, one can as well treat them as having no properties at all. This is illogic, of course. It makes a difference if a particle has properties or not, as we shall see, whether they can be known or not.

The ideas of superposition and entanglement that hover about Quantum Theory originate from only two kinds of experiments in physics that are badly explained or not explained at all. Superposition comes from 'double-slit experiments'. To explain the interference fringes that occur in those experiments as a result of particles going through two slits, a particle has to travel through both slits at the same time. This is wrong. Explanations for interference fringes in double-slit experiments go wrong right from the start: it is asserted that it is possible to produce one particle (or photon) at a time. That is just not possible. The fact that one click at a time is heard, or one black spot at a time appears on a detection screen, does not mean that one particle at a time has been produced. Enough nonsense has been written about this kind of experiments.

The strange interaction between entangled particles is the result of Bell-test experiments. Explanations for correlations that occur in these experiments also go wrong right from the start: it is asserted that the properties of particles cannot account for quantum mechanics predictions for these correlations. That is wrong. In this paper I will show that the properties of particles can very well account for those correlations.

Reading the books I was astonished to find how many people are willing to believe and accept what they cannot understand. No one understands superposition and entanglement physically. Particles can be entangled but that only means that they have opposite properties. It does not mean that they interact instantaneous at a distance. It was far from clear how to interpret the mathematics of Quantum Theory. This is where Bell experiments came in. They were meant to solve the interpretation problem for once and for all. That turned out wrong.

To account for quantum mechanics outcomes Einstein (?) introduced local hidden variables. Those were unknown properties of particles that had to account for outcomes of measurements on entangled particles. It was thought that those outcomes couldn't be accounted for by normal properties of the particles because of the Uncertainty Principle of Heisenberg. Apparently one conceived the wavefunction of a particle to be a state of superposition instead of a statistical description of possible real states a particle can be in.

David Bohm thought of a way to find out experimentally if local hidden variables could account for quantum mechanics outcomes. Then John S. Bell calculated that local hidden variables in no way could account for the quantum mechanics outcomes. Experiments performed by Alain Aspect and many others, showed quantum mechanics outcomes and so Bell's theorem seemed to be proven correct.

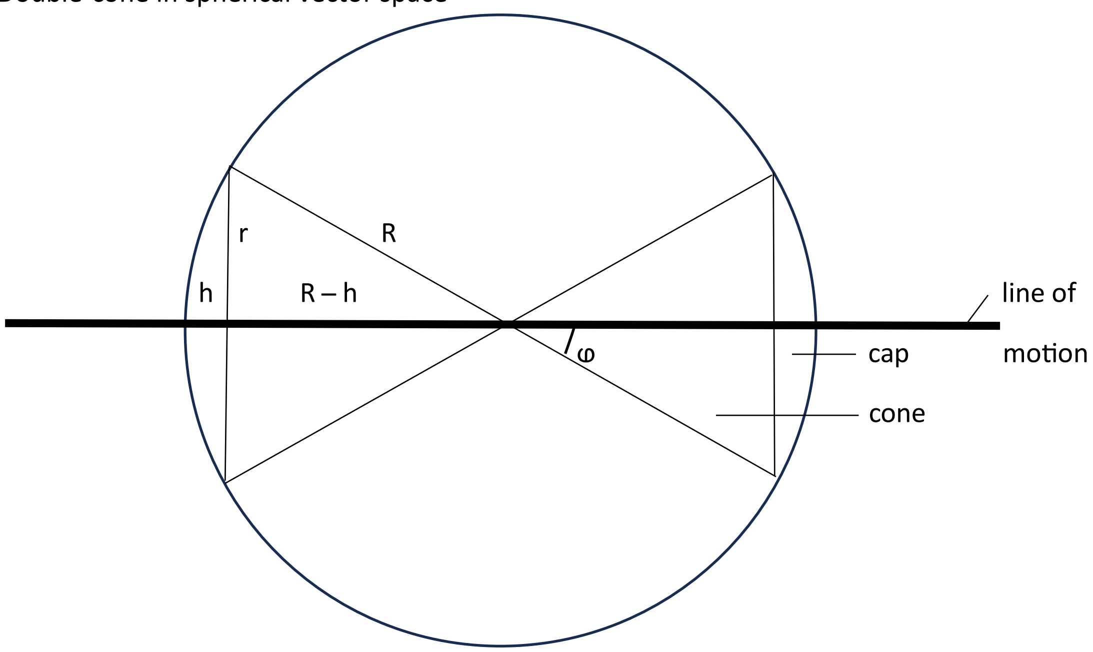
To falsify Bell's theorem I only have to show that the properties of entangled particles suffice to account for the quantum mechanics outcomes. There is no need for local hidden variables. To show this, I assume that spin of a particle can be represented by a vector and that spin directions of entangled particles can be represented by a pair of vectors pointing in opposite directions. That is all. As far as I know, the idea to represent spin as a vector is even accepted in quantum theory, whatever fancy names those vectors may have been given. During the process I discovered the Principle of Perspective. The Principle of Perspective is essential in the account for correlations in Bell experiments predicted by quantum mechanics. Bell came to his inequalities missing the Principle of Perspective. So his theorem was based on wrong inequalities and therefore his theorem is wrong.

The Principle of Perspective is about the perception of an object. The principle is not yet recognized. On one hand it is very simple and on the other hand it is very difficult to grasp. Everyone knows that one observer can perceive an object from only one direction, one point of view. This point of view is the perspective. It has nothing to do with time: whenever an object is observed by one observer, it is perceived from one direction. When two observers look at the same time to an object, they look from different viewpoints and see the object differently. They see two different objects as it were. The results of their observations from that object cannot be compared. Of course the results can be put side by side but the comparison of them doesn't mean anything. This is because observers perceive from their own reference frame and their observations are not equivalent. To describe the results of an observation of an object a coordinate system is needed. This coordinate system has to be defined in respect of the reference frame of an observer. In case of two observers there are two (different) reference frames. So there have to be two different coordinate systems if equally defined in respect of each reference frame. But the description of an object in respect of two coordinate systems is meaningless. And so is the comparison of results of observations from different viewpoints.

The opposite vectors, representing the spin directions of a pair of entangled particles, can considered to be one object. When two detectors each detect the spin direction of one particle of a pair, the results cannot be compared, as explained. The detections are different and not equivalent. Detections only are equivalent if made from one viewpoint. This is not possible in the real situation of an experiment on entangled particles but it gives a clue. Experiments show that certain pairs of particles give combinations of equal spin outcomes. This is due to (and depends on) the relative settings of the detectors. From one viewpoint it is easy to see that the condition for a pair to give equal outcomes, is that the spin direction of a particle is in the vector space between the centre perpendicular planes of the settings of the detectors (for a figure see fig.2 in [2]). This is how Bell drafted his inequalities (from one viewpoint) and this is why those inequalities have to be violated, because in reality spin directions of entangled particles are detected from two viewpoints. The real condition (from opposite viewpoints) for a pair to give equal outcomes is that the angle between the spin direction and the particle's trajectory (the line of motion) is smaller than the angle between the settings of the detectors.

Detections from one viewpoint are equivalent. Detections from different viewpoints can be kept equivalent if the object moves along with the second detector in its translocation from its common viewpoint with the first detector to its real position. Of course in reality an object doesn't move along with the detector. However, the opposite vector pairs representing the opposite spin directions of all the entangled pairs, make up a spherical vector space. I discovered that the relative movement of the detectors in respect of each other and in respect of the line of motion of the particles, divides the spherical vector space in two different vector spaces. The movements of the detectors produce a double-conical vector space (as part of the spherical vector space) around the line of motion of the particles (see fig.1). I described this in [1] and [2] and in [3] in the part that is called: Summary Visualization of Bell Experiments. The double-cone shaped vector space contains the opposite vector pairs representing the spin directions of the entangled pairs that give combinations of equal spin outcomes.

Fig.1: Double-cone in spherical vector space



By ‘deducing’ the vector spaces for combinations of equal spin outcomes and discovering the principle that is needed to find those spaces, I revealed the ‘mechanism’ in Bell-test experiments. I found a classical physical account for the quantum mechanics outcomes for correlations in Bell-test experiments, based only on the properties of the particles. This refutes Bell’s Theorem.

The proof

The probability for a pair of particles to show a combination of equal spin outcomes, given by quantum mechanics is: $\sin^2(\varphi/2)$. The probability for a combination of opposite spin outcomes is: $\cos^2(\varphi/2)$. The sum of those probabilities is 1, as it should be. The subtraction of these probabilities is called the correlation C and $C = -\cos\varphi$, φ being the relative angle between the settings of the detectors.

In my story the probability for a combination of equal outcomes, is the probability for a random generated pair of opposite vectors to end up in the double-cone. This probability corresponds to the ratio of the volume of the double-cone in respect of the total volume of the spherical vector space. I found the volumes and areas for caps and cones at Wikipedia.

Volume cap: $(1/3)\pi h^2(3R - h)$ Area cap: $2\pi Rh$

Volume cone: $(1/3)\pi r^2(R - h)$

The volume V of the double-cone is the volume of 2 cones plus 2 caps:

$V = 2(1/3)\pi r^2(R - h) + 2(1/3)\pi h^2(3R - h)$

$=(2/3)\pi\{r^2(R - h) + h^2(2R + (R - h))\}$

Because $r = R\sin\varphi$, $(R - h) = R\cos\varphi$ and $h = R - R\cos\varphi$ it follows:

$V = (2/3)\pi\{R^2\sin^2\varphi(R\cos\varphi) + (R - R\cos\varphi)^2(2R + R\cos\varphi)\}$

$= (2/3)\pi\{R^2\sin^2\varphi(R\cos\varphi) + (R^2 - 2R^2\cos\varphi + R^2\cos^2\varphi)(2R + R\cos\varphi)\}$

$= (2/3)\pi\{R^2\sin^2\varphi(R\cos\varphi) + 2RR^2 - 4RR^2\cos\varphi + 2RR^2\cos^2\varphi + RR^2\cos\varphi - 2RR^2\cos^2\varphi + RR^2\cos\varphi\cos^2\varphi\}$

$= (2/3)\pi R^3\{\sin^2\varphi(\cos\varphi) + 2 - 4\cos\varphi + 2\cos^2\varphi + \cos\varphi - 2\cos^2\varphi + \cos\varphi(\cos^2\varphi)$

$= (2/3\pi R^3\{\cos\varphi(\sin^2\varphi + \cos^2\varphi) + 2 - 3\cos\varphi\}$

$= (2/3\pi R^3\{\cos\varphi + 2 - 3\cos\varphi\}$

$= (4/3)\pi R^3\{1 - \cos\varphi\}$

To find the ratio of this volume in respect to the volume of the total sphere, we have to divide by the volume of the sphere ($(4/3)\pi R^3$) and then we find for the ratio: $(1 - \cos\varphi)$. The value of this ratio is between 0 and 2 and that is not the probability for a random vector to end up in the double-cone. This is because the volume of the double-cone is defined by the tip angles of the cones, being 2φ. So when φ approaches 180° the volume of the double-cone takes the total volume of the sphere and when φ approaches 360° it takes 2 times the volume of the total sphere. So the real probability for a random vector to end up in the double-cone is the ratio divided by 2: $(1 - \cos\varphi)/2$. This is a probability between 0 and 1.

I still cannot prove that this probability $(1 - \cos\omega)/2$ is the same as quantum mechanics probability $\sin^2(\omega/2)$ but if you draw the diagram for each function, you will see that they are identical. Moreover, I found in a book from 1931 by R. Carmichael and E. Smith 'Mathematical Tables and Formulas' at page 217, formula 31: $\cos 2\alpha = 1 - 2\sin^2\alpha$, showing that the probabilities indeed are identical.

The same goes of course for the ratio of the total area of the caps in respect to the total area of the sphere.

Area of the caps is: $2(2\pi Rh)$. This is $4\pi R^2(1 - \cos\omega)$. Dividing by the area of the spere ($4\pi R^2$) this gives the ratio: $(1 - \cos\omega)$ and thus the same probability $(1 - \cos\omega)/2$ for a random vector pair to end up in the double-cone and show a combination of equal spin outcomes.

Some try to prove or disprove Bell's Theorem mathematically or statistically. This is not possible. Bell's Theorem is a 'no go' theorem: it goes as long as no counter example has been given. There is no other way to disprove a 'no go' theorem. This is like the modus operandi of the Universe: if something exists, it can exist. If something cannot exist, it will not exist. This has nothing to do with anthropic reasoning. One will never know if something can exist until it exists (as one will never know if a 'no go' theorem holds until a counter example has been given). I suspect that something that exists, also is comprehensible somehow. If something is not comprehensible, like superposition or the interaction idea of entanglement, it probably does not exist.

References:

1) https://vixra.org/abs/2512.0004 On the Detection of Direction Gerard van der Ham
2) https://vixra.org/abs/2507.0183 On the Mechanism in Bell-test Experiments Gerard van der Ham
3) https://bell-game-challenge.vercel.app/ The Principle of Perspective Gerard van der Ham
4) Robert D. Carmichael and Edwin R. Smith; Mathematical Tables and Formulas, 1931