# Why Bell's experiment is meaningless

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**Abstract**

We demonstrate that a Bell experiment asks the impossible of a Kolmogorovian correlation. An Einstein locality explanation in Bell's format is therefore excluded beforehand by way of the experimental and statistical method followed.

Bell's correlation formula; basic probability

## 1 Introduction

In 1935, Einstein Podolsky and Rosen initiated a debate about the foundation of quantum theory in [1]. Their work established what has been called entanglement.

### 1.1 Bell Experiment

Bell experiments need no further introduction. One can find a proper example in e.g. Weiss's experiment of 1998 [2].

Let's take $x = \angle(a, b)$, the angle in the plane orthogonal to the direction of propagation. The angle is in the interval $0 \leq x < 2\pi$. The positioning is orthogonal the line of travelling of the two entangled particles from the source S towards the observations at Alice and Bob. The unity setting vector, a, refers to Alice's instrument. The unity vector, b, refers to Bob's instrument. For photons it suffices to look at the orthogonal plane.

Suppose there are $N$ number of entangled photon pairs in the experiment. During the experiment the spin of the photons are measured. If we subsequently denote $N(x|eq)$ the number of up-up or down-down spin pair measurements in the total of $N$ pairs under the angle, $x$. $N(x|eq)$ is equal to the sum of the countings $C(x|up, up)$ and $C(x|down, down)$.

The left "up" in up-up is Alice's measurement. The right "up" is Bob's. Similar for the other combinations. Moreover, with the assumption of perfect measurement the number of up-down or down-up measurements $N(x|neq)$, is equal to $N - N(x|eq)$.

### 1.2 Correlation

It is common practice in spin-spin entangled experiments to compute the Kolmogorovian Bell correlation [3] as a raw product moment (rpm) correlation

$$R(x) = \frac{N(x|neq) - N(x|eq)}{N} \tag{1}$$

It is then easy to see that

$$R(x) = 1 - 2g(x) \tag{2}$$

With $g(x) = \frac{N(x|eq)}{N}$ the relative frequency for the observation. Note that the angle under "eq" condition $X = x$ is a continuous random variable. The probability of a continuous variable in a single point is zero [4, page 121]. Therefore, $g(x)$ in (2) isn't a probability.

### 1.3 Quantum Correlation

It is well known that the quantum correlation is $Q(x) = \cos(x)$. This can, via simple trigonometry, also be written like

$$Q(x) = 1 - 2\sin^2(x/2) \tag{3}$$

If we then want to know if it is possible for a Bell type correlation to be equal to the quantum correlation it follows that $F(x)$ must be associated to $\sin^2(x/2)$. Can this be accomplished? Note that $\sin^2(x/2)$ isn't a monotone function. Even if one insists that $g(x) = \frac{N(x|eq)}{N}$ is a nonzero probability, one runs into trouble with $g(x) = \sin^2(x/2)$.

## 2 Probability

For clarity, the hypotheses are

$$\begin{aligned} H_0 &: R(x) \text{ cannot be equal to } Q(x) \\ H_1 &: R(x) \text{ can be equal to } Q(x) \end{aligned} \tag{4}$$

In the first place let us note that $g(x)$ is the relative frequency, $N(x|eq)/N$, of a random variable $X$ where the "eq" must be observed under angle $x$. The angle $x$ is a real continuous variable in the interval between 0 and $2\pi$. Secondly, the probability distribution $F(\dots)$ is, for a continuous random variable, associated to the probability

$$P[y \leq X \leq x] = F(x) - F(y) \tag{5}$$

Let us then look at $P[0 \leq X \leq x]$ and employ the implicit requirement that when $R(x)$ from Eq(2) is equal to $Q(x)$ from Eq(3) it then follows that

$$P[0 \leq X \leq x] = F(x) - F(0) \tag{6}$$

The $F(x)$ is a cumulation of relative frequencies.

$$F(x) = \sum_{y \leq x} \frac{N(X=y)}{N} \tag{7}$$

However, if the relative frequencies are $\frac{N(X=y)}{N} = \sin^2(y/2)$, then the following is found.

$$F(x) = \sum_{y \leq x} \sin^2(y/2) \tag{8}$$

## 2.1 Density

The probability density $f(x)$ is defined by

$$f(x) = \frac{d}{dx} F(x) \tag{9}$$

So in this case of equation (8),

$$f(x) = \frac{d}{dx} \sum_{y \leq x} \sin^2(y/2) = \frac{d}{dx} \sin^2(x/2) = \frac{1}{2} \sin(x) \tag{10}$$

But, as we know, a probability density must be positive or zero in the interval under study. For all x with $0 \leq x \leq 2\pi$ the density in equation (10) is not always postive or zero. Note that $y < x$ are not a function of the endpoint $x$.

## 2.2 Continuous

Suppose that the counter argument will be: you must integrate, it is a continuous variable. True, but then mind [4, page 121]. The equation (8) must be written

$$F(x) = \int_0^x \sin^2(y/2) dy \tag{11}$$

This implies that the density is

$$f(x) = \sin^2(x/2) \tag{12}$$

Agreed this surely is positive or zero in the interval $0 \leq x \leq 2\pi$. But then $f(x)$ must integrate to unity. We nevertheless find

$$\int_0^{2\pi} \sin^2(x/2) dx = \pi > 1 \tag{13}$$

## 3 Conclusion

In the first place it must be noted that the present criticism on Bell experiment rpm correlation methodology stands not on its own. Others like e.g. Hess [5] have voiced doubts about Bell proofs as well.

In the second place the following is discussed. When we ask the question whether or not in a spin-spin entangled Bell experiment, the quantum correlation can be produced from a Kolmogorovian based correlation, an impossible requirement is implicit. Such a Kolmogorovian correlation is required to not be a Kolmogorovian entity.

In other words: The Kolmogorovian correlation in this kind of experiments hasn't a chance to come close to quantum. Not because of the fact that a local Kolmogorovian explanation is absent in nature. It is because the test in experiment with rpm correlation asks the logically impossible of a local hidden variables model. Other combinations for Eqs (1)-(3) also run into a conflict with Kolmogorovian probability.

An experiment with rpm correlation is pointless. This means that violation of the famous CHSH is meaningless. It does not allow any conclusion about the presence or absence of an Einsteinian explanation of incompleteness of quantum theory in nature. Such an explanation is excluded beforehand via the experimental and statistical method followed. The reason is that by means of a contradictory requirement, the hypothesis $H_1$ in Eq(4) has been logically excluded from the observations. Therefore we may claim that the rpm correlation experiments are meaningless. Note, our finding is not an alternative to the CHSH inequality. For, $\sin^2(x/2)$ isn't a quantum probability in $0 \leq x < 2\pi$ either. It represents a flaw in the statistics employed in experiments testing that inequality in nature.

## Declarations

The author has no conflict of interest. The work was not funded.
All data generated or analysed during this study are included in this published article.

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