Bell's Theorem refuted, and Bell's Error corrected, all on one page

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Abstract: Taking all elements of physical reality to be *beables* (things that exist), our local-realistic study of Bell (1964) rests on two core principles: Einstein-locality (no beable travels superluminally) and Bohr-realism (some beables change interactively). This note (with expectation E, probabilities P, spin-half particles p), exposes the physical laws that correct Bell's error and refute his theorem.

Introduction: Our local-realistic study of Bell (1964) – see References – has Alice and Bob as aides. They, with their equipment, are spacelike-separated. Hidden-variables λ (denoting angular momentum), capture the pairwise correlation of each particle-pair: i.e., $\lambda_i^\alpha + \lambda_i^\beta = 0$, with run-number $i = 1, 2, .., N$, and test-locale α or β. Let the i-th run of a test deliver A^+B^+, as in our flowchart; explanations follow. Note that ${}_p(\lambda_i^\alpha)$ changes to ${}_p(a^+)$ via a local interaction; ${}_p(\lambda_i^\beta)$ similarly to ${}_p(b^+)$.

$$A^+ \equiv +1 = \{a \cdot (a^+)] \leftarrow {}_p(a^+) \leftarrow [\overset{+}{\underset{-}{a}}] \leftarrow {}_p(\lambda_i^\alpha) \;\leftarrow Ⓢ \rightarrow\; {}_p(\lambda_i^\beta) \rightarrow [\overset{+}{\underset{-}{b}}] \rightarrow {}_p(b^+) \rightarrow [(b^+) \cdot b\} = +1 \equiv B^+$$

... α, the locale of autonomous Alice⌋ ⌊Source⌋ ⌊β, the locale of autonomous Bob ...

Item	Meaning
α and β	The spacelike-separated locales of Alice and Bob.
a, (b)	Principal axis of Alice's (Bob's) "polarizer": $[\overset{+}{\underset{-}{a}}]$ $([\overset{+}{\underset{-}{b}}])$.
(a, b)	The angle between a and b, each being a unit vector.
$\pm 1 \equiv A^\pm, \pm 1 \equiv B^\pm$	Respectively, Alice's and Bob's measurement results.
$\{a \cdot (?)][\overset{+}{\underset{-}{a}}] \leftarrow {}_p(\lambda_i^\alpha)$	Alice's "polarizer-analyzer" about to test particle ${}_p(\lambda_i^\alpha)$.
${}_p(\lambda^\alpha_i)$, ${}_p(\lambda_i^\beta)$	Particles are uniquely identified by i and α or β.
${}_p(\lambda_i^\beta) \rightarrow [\overset{+}{\underset{-}{b}}][(?) \cdot b\}$	Bob's "polarizer-analyzer" about to test particle ${}_p(\lambda_i^\beta)$.
$P(XY) = P(X)P(Y\|X)$	The general product rule from probability theory.

Analysis: With certainty, $P(A^+B^+) + P(A^+B^-) + P(A^-B^+) + P(A^-B^-) = 1.$ (1)

$$\therefore E(AB) \equiv P(A^+B^+) - P(A^+B^-) - P(A^-B^+) + P(A^-B^-) = -a \cdot b = -\cos(a, b) \;... \tag{2}$$

$$... \text{ from Bell's eqn.(3).} \therefore P(A^+B^+) + P(A^-B^-) = \tfrac{1}{2}[1 - \cos(a, b)] = \sin^2 \frac{(a, b)}{2}. \tag{3}$$

Now $P(A^\pm) = P(B^\pm) = 1/2$. And results $AB = +1$ are equiprobable, as are $AB = -1$. (4)

$$\therefore P(A^+B^+) = P(A^-B^-) = \tfrac{1}{2} \sin^2 \frac{(a, b)}{2}. \therefore P(A^+B^-) = P(A^-B^+) = \tfrac{1}{2} \cos^2 \frac{(a, b)}{2}. \tag{5}$$

$$\therefore P(B^+|A^+) = P(B^-|A^-) = \sin^2 \frac{(a, b)}{2} \text{ and } P(A^+|B^-) = P(A^-|B^+) = \cos^2 \frac{(a, b)}{2}. \tag{6}$$

Explanation: (1) is an axiom of normalisation. $\equiv$ denotes "true by definition", so (2) defines the expectation in Bell (1964) eqn.(3). Our (3) follows from the sum of (1) & (2): each of which is certain, as are their consequences. (4) follows from the nature of the tests (N particle-pairs drawn from an infinite set, N large), and *predetermined* does not mean *pre-existing*. (5) shows the local-realistic correlations (the local-realistic laws) that refute Bell's theorem. (6) shows the laws that we sought.

Conclusions: Subluminal-travel and interactive-changes ensure that Einstein-locality and Bohr-realism hold true here. Equations (1) & (2) expose the underlying deterministic laws with certainty; they thus establish clear correlations between the paired results. The error we correct lies in Bell's specification of an inapplicable expectation in his second equation. Our local hidden-variable framework conforms fully to standard quantum mechanical predictions. It then refutes Bell's theorem. Evaluating the first paragraph of his original conclusion (p.199), under the boundary conditions $(a, b) = 0$ or π, helps to reveal the mechanism by which individual results are explicitly determined.

Acknowledgment: To Roger L. Mc Murtrie for many beneficial deeds and exchanges.

References: Bell, J. S. (1964). "On the Einstein Podolsky Rosen paradox." Physics 1, 195-200. http://cds.cern.ch/record/111654/files/vol1p195-200_001.pdf