Bell's theorem refuted

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Abstract: Bell's theorem has been described as the most profound discovery of science, one of the few essential discoveries of 20th Century physics, indecipherable to non-mathematicians. Let's see.

Introduction: Let β denote the thought-experiment in Bell (1964) and let **B**(.) denote Bell's equations (.). From the line before **B**(1), let $A^{\pm}$ & $B^{\pm}$ denote the independent same-instance results therein. Then $A^{\pm}$ and $B^{\pm}$ are pairwise correlated via Bell's functions A & B and the latent variable λ. That is:

$$A(a,\lambda) = \pm 1 = A^{\pm},\ B(b,\lambda) = \mp 1 = B^{\mp}\text{: ie, if } a=b \text{ then } A^{+}B^{-} = A^{-}B^{+} = -1\text{; as in } \mathbf{B}(13). \quad (1)$$

Then, reserving P for probabilities, let's replace Bell's expectation $P(\vec{a},\vec{b})$ in **B**(2) with its identity $E(a,b\,|\,\beta)$. Then, from (1), **B**(2), RHS **B**(3) and the line below **B**(3), this is Bell's theorem under β:

$$E(a,b\,|\,\beta) = \int d\lambda\, \rho(\lambda) A(a,\lambda) B(b,\lambda) \neq -a\cdot b \text{ [sic]}. \quad (2)$$

Refutation-β: $E(a,b\,|\,\beta)$ is the average result under β with settings a & b. So, via (1) & LHS (2):

$$\begin{aligned} E(a,b\,|\,\beta) &= \int d\lambda\, \rho(\lambda)[(A(a,\lambda\,|\,\beta)=1)(B(b,\lambda)=1) - (A(a,\lambda)=1)(B(b,\lambda)=-1) \\ &\quad -(A(a,\lambda\,|\,\beta)=-1)(B(b,\lambda)=1) + (A(a,\lambda)=-1)(B(b,\lambda)=-1)] \quad (3) \\ &= P(A^{+}B^{+}\,|\,\beta) - P(A^{+}B^{-}\,|\,\beta) - P(A^{-}B^{+}\,|\,\beta) + P(A^{-}B^{-}\,|\,\beta) \quad (4) \\ &= P(A^{+}\,|\,\beta)P(B^{+}\,|\,\beta A^{+}) - P(A^{+}\,|\,\beta)P(B^{-}\,|\,\beta A^{+}) - P(A^{-}\,|\,\beta)P(B^{+}\,|\,\beta A^{-}) \\ &\quad + P(A^{-}\,|\,\beta)P(B^{-}\,|\,\beta A^{-}) \text{ via the product rule for outcomes correlated as in (1).} \quad (5) \\ &= \tfrac{1}{2}\left[P(B^{+}\,|\,\beta A^{+}) - P(B^{-}\,|\,\beta A^{+}) - P(B^{+}\,|\,\beta A^{-}) + P(B^{-}\,|\,\beta A^{-})\right] \text{ for, with} \\ &\quad \lambda \text{ a random latent variable, the marginal probabilities } \left[\text{like } P(A^{+}\,|\,\beta)\right] = \tfrac{1}{2}. \quad (6) \\ &= \tfrac{1}{2}\left[\sin^2\tfrac{1}{2}(a,b) - \cos^2\tfrac{1}{2}(a,b) - \cos^2\tfrac{1}{2}(a,b) + \sin^2\tfrac{1}{2}(a,b)\right]\text{: replacing the probability} \\ &\quad \text{functions in (6) with } \beta\text{-based laws akin to Malus' Law for light-beams.} \quad (7) \\ &= \sin^2\tfrac{1}{2}(a,b) - \cos^2\tfrac{1}{2}(a,b) = -\cos(a,b) = -a\cdot b. \text{ So RHS (2) is refuted: QED.} \quad (8) \end{aligned}$$

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Comments: (i) Bell's theorem, derived in the context of thought-experiment β, is refuted via elementary probability theory. (ii) Bell's related inequality—**B**(15), the basis for (2)—is refuted in Watson (2020F.v3:2-3) via high-school mathematics. (iii) Laws similar to those in (7) refute Bell's theorem elsewhere; eg, we next refute Bell's theorem via an idealization of experiment α, Aspect (2004).

Refutation-α: $E(a,b\,|\,\alpha)$ is the average result under α. Therein, (1)-(2) above are replaced by:

$$A(a,\lambda) = \pm 1 = A^{\pm}, B(b,\lambda) = \pm 1 = B^{\pm}\text{: ie, if } a = b \text{ then } A^{+}B^{+} = A^{-}B^{-} = 1. \tag{9}$$

$$E(a,b\,|\,\alpha) = \int d\lambda\, \rho(\lambda)A(a,\lambda)B(b,\lambda) \neq \cos 2(a,b) \text{ [sic]. However, akin to (6):} \tag{10}$$

$$E(a,b\,|\,\alpha) = \tfrac{1}{2}\left[P\left(B^{+}\,|\,\alpha A^{+}\right) - P\left(B^{-}\,|\,\alpha A^{+}\right) - P\left(B^{+}\,|\,\alpha A^{-}\right) + P\left(B^{-}\,|\,\alpha A^{-}\right)\right] \tag{11}$$

$$= \tfrac{1}{2}\left[\cos^2(a,b) - \sin^2(a,b) - \sin^2(a,b) + \cos^2(a,b)\right]\text{: replacing the probability functions in (11) with } \alpha\text{-based laws akin to Malus' Law for light-beams.} \tag{12}$$

$$= \cos^2(a,b) - \sin^2(a,b) = \cos 2(a,b)\text{. So RHS (10) is refuted: QED again.} \tag{13}$$

Conclusions: (i) In (7) & (12) we provide the first of a family of laws that refute Bell's theorem in any setting. (ii) For (we note), even in Malus' time: 'The aim of physics is to discover *the laws of Nature* governing our objectively-existing world. ... to search for the abstract mathematical description that allows us to explain and predict—in a quantitative way—the regularities observed or to be discovered in physical phenomena which exist independent of any agent,' after Kupczynski (2015:2).

References:

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