Bell's inequality refuted irrefutably on Bell's own terms

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Abstract Using elementary mathematics, and consistent with claims that we've advanced since 1989, we refute Bell's inequality irrefutably on Bell's own terms. In sum, in Bell 1964: (14b) $\neq$ (14a).

1. Introduction

(i) Bell's theorem has been described as one of the most profound discoveries of science. (ii) Yet, despite this fame, Bell (1990:7) lived on the horns of a dilemma wrt the significance of his theorem. (iii) As an introduction to Watson (2018e), which demolishes any need for non-locality or naive-realism in physics—and at the level of high-school mathematics—we resolve Bell's dilemma on his terms.

2. Analysis

(i) Bell (1964) is available free-online, see References; it will be helpful to have it on hand. (ii) Let Bell-(1) be short for Bell 1964:(1); etc. (iii) Let Bell-(14a), (14b), (14c) identify the three unnumbered mathematical-expressions after Bell-(14). (iv) Then, via Bell-(1) and LHS Bell-(2), we see the functions required to analyze Bell's work: (v) Result A is given by $A(\vec{a},\boldsymbol{\lambda}) = \pm 1$, etc. (vi) The expectation value for $A(\vec{a},\boldsymbol{\lambda})B(\vec{b},\boldsymbol{\lambda})$—ie, the average over the product of paired-results from such tests—is given by $P(\vec{a},\vec{b})$, etc. (vii) Thus, working on an infinite plane with $(\vec{b},\vec{c}) = (\vec{a},\vec{c}) - (\vec{a},\vec{b})$ for simplicity—using facts at one with quantum theory, observation and true local realism (Watson 2018e)—we find, via

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\begin{aligned}
\text{Bell-(1)-(2):}\, A(\vec{a},\boldsymbol{\lambda}) &= \pm 1, B(\vec{b},\boldsymbol{\lambda}) = \pm 1, C(\vec{c},\boldsymbol{\lambda}) = \pm 1 \text{ represent Bell's result functions,} && (1)\\
\text{with} -1 \leq P(\vec{a},\vec{b}) &\leq 1, -1 \leq P(\vec{a},\vec{c}) \leq 1, -1 \leq P(\vec{b},\vec{c}) \leq 1 \text{ the related expectations.} && (2)\\
\text{Now it's a fact that } xy &\leq y \text{ if } x \leq 1 \text{ and } 0 \leq y\text{; ie, for us, it's an eternal truth by definition.} && (3)\\
\text{So } P(\vec{a},\vec{b})[1 + P(\vec{a},\vec{c})] &\leq 1 + P(\vec{a},\vec{c}) \text{ is also an eternal truth [among others] for all } \vec{a},\vec{b},\vec{c}. && (4)\\
\text{So, reworking (4)} &- \text{ready for Bell's use of absolute values (tho not needed by us)} - && (5)\\
\text{we have a new fact:}\, 0 &\geq |P(\vec{a},\vec{b}) - P(\vec{a},\vec{c})| - 1 + P(\vec{a},\vec{b})P(\vec{a},\vec{c}), \text{ for all } \vec{a},\vec{b},\vec{c}. && (6)\\
\text{Then, from Bell-(15):}\, 0 &\geq |P(\vec{a},\vec{b}) - P(\vec{a},\vec{c})| - 1 - P(\vec{b},\vec{c}) \text{ is Bell's famous inequality.} && (7)\\
\text{And if } (\vec{a},\vec{b}) = (\vec{a},\vec{c}) &: \text{then } P(\vec{b},\vec{c}) = P(\vec{b},\vec{b}) = -1 \text{ per Bell-(13). So (7) holds and} && (8)\\
\text{all's well. However} &: \text{as Bell (1964) well-knows, via quantum theory (QT), as at} && (9)\\
\text{Bell-(2)-(3):}\, P(\vec{a},\vec{b}) &= -\cos(\vec{a},\vec{b})\text{, etc. [Or see Watson 2018e:(19) without QT.] So} && (10)\\
\text{Bell needs } P(\vec{a},\vec{b})P(\vec{a},\vec{c}) &\geq -P(\vec{b},\vec{c}) \text{ for all } \vec{a},\vec{b},\vec{c}\text{, except if } (\vec{a},\vec{b}) = (\vec{a},\vec{c}),\text{ for (7) to hold.} && (11)\\
\text{Otherwise (7) could be} &> 0 \text{ for some } \vec{a},\vec{b},\vec{c}\text{, contrary to its upper-bound. So, from (11)} && (12)\\
\text{via ¶4(vi), Bell needs } 0 &\geq \sin(\vec{a},\vec{b})\sin(\vec{a},\vec{c}) \text{ and } (\vec{a},\vec{b}) = (\vec{a},\vec{c}) \text{ for (7) to be a fact. Alas,} && (13)\\
\text{here's the eternal truth} &: \text{Bell-(15) is false for } \sin(\vec{a},\vec{b})\sin(\vec{a},\vec{c}) > 0 \text{ and } (\vec{a},\vec{b}) \neq (\vec{a},\vec{c})\text{; ie,} && (14)\\
\text{as seen in Figure 1, (7)} &> 0 \text{ for some } \vec{a},\vec{b},\vec{c} : \text{thereby breaching Bell's upper-bound of 0.} && (15)\\
\text{So, as claimed in 1989} &: \text{Bell-(15) is flawed.} \textit{QED.} \text{ And the source of Bell's error is} && (16)\\
\text{Bell-(15)} = \text{(14b)} &\neq \text{Bell-(14a): with Bell's theorem thus refuted at its source.} \textit{QED.} && (17)\\
\text{So Bell's (1964:196-7)} &: \text{"not possible" and "contradiction" are unjustified.} \textit{QED.} && (18)\\
\text{Also: Bell's conclusion} &- \text{Bell (1964:199)} - \text{is baseless; see Watson (2018e). Also, for all} && (19)\\
\vec{a},\vec{b},\vec{c} \text{ in our (4)-(6):}\, 0 &\geq |P(\vec{a},\vec{b}) - P(\vec{a},\vec{c})| - 1 + P(\vec{a},\vec{b})P(\vec{a},\vec{c})\text{. Whereas, for Bell in (7),} && (20)\\
\text{we can have: } \tfrac{1}{2} &\geq |P(\vec{a},\vec{b}) - P(\vec{a},\vec{c})| - 1 - P(\vec{b},\vec{c})\text{; as allowed at (12).} \textit{QED.} && (21)
\end{aligned}
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3. Conclusions

(i) Whatever the justification for Bell's (14b), it is mathematically false. (ii) Further, in the context of Bell (1964)—the EPR-Bohm experiment—it is unphysical: akin—see Watson (2018e)—to the presumption that naive-realism might succeed in a quantum setting. (iii) Moreover, whatever the assumption, it is also unwarranted: for, against Bell, Watson (2018e)—with its true local realism—delivers the same results as quantum theory and observation; thus showing that Bell-(2) does equal Bell-(3), as we used in (10)-(11). (iv) So Bell's theorem is refuted irrefutably here, on Bell's own terms. (vi) We conclude, as Bell (1990:9) contemplated: he and his supporters were being rather silly.

4. Appendix

(i) The opaque white-plane of Figure 1 represents the upper-bound 0 of our relation (6)—valid for all $\vec{a}, \vec{b}, \vec{c}$—with $x = (\vec{a}, \vec{b})$, $y = (\vec{a}, \vec{c})$; in radians. (ii) So all positive numbers lie behind the plane, hidden from view. (iii) The plot is (7), when true: ie, Bell's famous inequality overlays the plane in blue when its upper-bound is 0, as claimed. (iv) Against our (6) with its 100% validity, Bell's inequality rates 50%. (v) In effect, we cut Bell's Gordian Square (of whatever dimension) into subordinate squares: our white-spaces—in which (7) is false—being those defined in (14). (vi) nb: from ¶2(vii) and (10-(11),

$$\text{Bell needs: } 0 \geq \cos[(\vec{a}, \vec{c}) - (\vec{a}, \vec{b})] - \cos(\vec{a}, \vec{b}) \cos(\vec{a}, \vec{c}) = \sin(\vec{a}, \vec{b}) \sin(\vec{a}, \vec{c}); \text{ except if } (\vec{a}, \vec{b}) = (\vec{a}, \vec{c}). \quad (22)$$

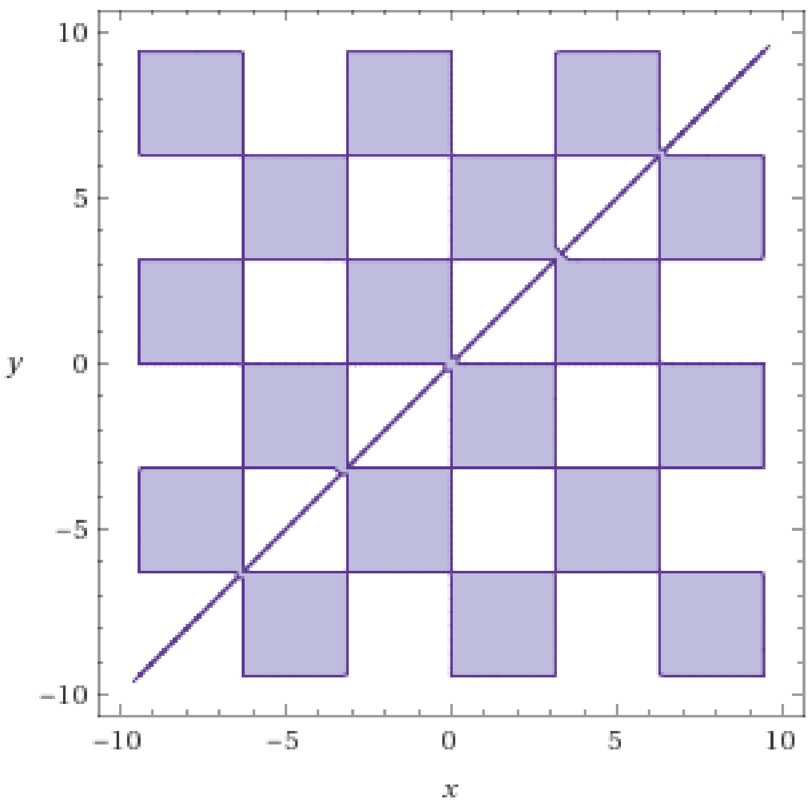

Figure 1: Our (7), Bell's famous inequality, in blue when true; otherwise false. Distortions near the line $y = x$ —ie, $(\vec{a}, \vec{c}) = (\vec{a}, \vec{b})$— are simply graphical departures from points of intersection.

5. Acknowledgments

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