To Wiseman and Cavalcanti: All Bell inequalities are false; the principle of relativity is true

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Abstract 'Experiments violating a Bell inequality (BI) thus leave us [realists with a related credo] no option: the principle of relativity is false. The world is nonlocal,' Wiseman and Cavalcanti (2015). But we show that elementary math also violates a BI. Moreover: under that principle of relativity, elementary math elsewhere shows that wholistic mechanics (WM)—the synthesis of classical and quantum mechanics—also violates a BI. (That is, via WM and its relativistically-causal variables, quantum correlations are wholly explicable in our objective relativistically-causal world.) So—*with 3 ways to violate a BI*—true-realists find: the principle of relativity is true; it's Bell's theorizing that's false; nonlocality *non est.* Importantly: for STEM students and teachers, and against popular opinion-pieces about quantum nonlocality, our results require no knowledge of QM. Let's see.

Keywords Bell's inequality, EPR-Bohm, nonlocality, relativistic causality, wholistic mechanics.

1 Introduction and Analysis

1.0. (i) 'The realist camp [eg, Dürr, Goldstein, Maudlin, Norsen, Zanghì] has the following credo: Bell's theorem uses only one assumption: local causality (or 'locality' as we usually call it for short). This is the only reasonable way to apply the principle of relativity for statistical theories. It is essentially what EPR assumed in 1935. They showed that operational quantum mechanics is nonlocal, and Bell showed [sic] in 1964 that adding hidden variables cannot solve the problem. Experiments violating a Bell inequality thus leave us with no [sic] option: the principle of relativity is false [sic]. The world is nonlocal [sic],' Wiseman and Cavalcanti (2015:9). (ii) 'The moral (Bell's theorem): quantum correlations falsify [sic] the hypothesis that, in any laboratory, nature carries the answer to any question which may be put to it, and answers without knowing which questions are being put elsewhere,' Wiseman (2014:469).

1.1. Against §1.0, this note is both an Appendix and an easy introduction to Watson (2020E). Honoring David Bohm, let β denote the EPR-Bohm experiment studied by Bell (1964): which—free-

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online; see References—is here taken as read. Further, reserving P for probabilities, let's replace Bell's expectation $P(\vec{a}, \vec{b})$ with its identity $E(a, b|\beta)$.

1.2. Then, from Bell 1964:(15), here's his famous BI in our terms:

$$\text{BI: } |E(a, b|\beta) - E(a, c|\beta)| - 1 - E(b, c|\beta) \text{ [sic]} \leq 0. \tag{1}$$

1.3. So, from (1) and with their limits, we have the following expectations:

$$-1 \leq E(a, b|\beta) \leq 1, \ -1 \leq E(a, c|\beta) \leq 1, \ -1 \leq E(b, c|\beta) \leq 1. \tag{2}$$

$$\therefore E(a, b|\beta)[1 + E(a, c|\beta)] \leq 1 + E(a, c|\beta), \tag{3}$$

$$\because \text{ if } V \leq 1, \text{ and } 0 \leq W, \text{ then } VW \leq W. \tag{4}$$

$$\text{So, from (3): } E(a, b|\beta) - E(a, c|\beta) \leq 1 - E(a, b|\beta)E(a, c|\beta). \tag{5}$$

$$\text{Similarly: } E(a, c|\beta) - E(a, b|\beta) \leq 1 - E(a, b|\beta)E(a, c|\beta). \tag{6}$$

1.4. Therefore—irrefutably from (5)-(6), and thus *never false*—here's our inequality (say, WI):

$$\text{WI: } |E(a, b|\beta) - E(a, c|\beta)| - 1 + E(a, b|\beta)E(a, c|\beta) \leq 0. \tag{7}$$

1.5. Irrefutable (7) is also derived via classical mechanics (CM); see Watson (2020E), where math, CM, QM and experiments unite as one whole under WM (wholistic mechanics). So, simplifying, let's test BI-(1) and WI-(7) under β with:

$$\text{Test-settings: } -\pi < (a, c) < 0, 0 < (a, c) < \pi; (a, b) = k(a, c), (b, c) = (1 - k)(a, c); 0 < k \leq \tfrac{1}{3}. \tag{8}$$

$$\text{Test-functions: } E(a, b|\beta) = -\cos k(a, c), E(b, c|\beta) = -\cos(1 - k)(a, c), E(a, c|\beta) = -\cos(a, c). \tag{9}$$

1.6. (i) (8) allows $(a, b), (b, c)$ and (a, c) to be co-planar at any reasonable orientation to the line-of-flight axis. (ii) (9) equates to QM values (as it should): but is derived (by us) via CM under relativistic causality; see Watson (2020E).

1.7. Then, under (8)-(9): (i) since WI-(7) is irrefutable, we can observe its compliant behavior; (ii) and if BI-(1)'s RHS value exceeds zero, we can observe where it is false.

1.8. To observe such results: with $0 < k \leq \frac{1}{3}$ —per (8)— enter the k of your choice into a copy of

plot[|cos(x)-cos((k)x)|-1+cos(x)cos((k)x) and |cos(x)-cos((k)x)|-1+cos((1-k)x)],-π<x<π (10)

1.9. Paste the new expression, say (11), into WolframAlpha®: free-online; see References. Enjoy! For physics is an experimental science, combining theory and practice as we seek Nature's laws.

1.10. We find: WI-(7) everywhere true; whereas, under (8)-(9), BI-(1) is everywhere false. QED.

2 Conclusions

> 2.0. 'Now nobody knows just where the boundary between the classical and quantum domain is situated. ... More plausible to me is that we will find that there is no boundary. It is hard for me to envisage intelligible discourse about a world with no classical part—no base of given events, be they only mental events in a single consciousness, to be correlated. On the other hand, it is easy to imagine that the classical domain could be extended to cover the whole. The wavefunctions—[not beables in our terms; in agreement with Bell (2004:53)]—would prove to be a provisional or incomplete description of the quantum-mechanical part, of which an objective account would become possible. It is this possibility, of a homogeneous account of the world, which is for me the chief motivation of the study of the so-called "hidden variable" possibility,' Bell (2004:29-30); emphasis added.

2.1. We agree: and in Watson (2020E) we deliver. Further: with *elementary* math here violating BI-(1) so easily, Watson's (2020E) conclusions are reinforced. In particular: Bell's formulations of local causality—eg, Bell (1964); Bell (1975a), aka Bell (1976)—fall to relativistically-causal wholistic mechanics (WM). WM—the synthesis of CM and QM—itself based on elementary analysis.

2.2. Now, (unlike naive-realists): true-realists allow that, even in CM—eg, Malus' experiments on light-beams c1810—some existents change interactively. So measurement interactions may deliver new—not pre-existing—values. Thus, via the principle of relativity, true-realists conclude: our world is relativistically-causal; quantum correlations are wholly and locally explicable; Bell's work under β—so readily violated—is *false*: as is §1.0.

2.3. So the principle of relativity is true, nonlocality *non est*; and with certainty: Bell did not show anywhere that adding hidden variables cannot solve the problem of nonlocality.

> 2.4. 'I think somebody will find a way of saying that [relativity and QM] are compatible. But I haven't seen it yet. For me it's very hard to put them together, but I think somebody will put them together,' Bell(1990:10). Endnote: see Watson (2020E).

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