Review of: "A Presupposition of Bell's Theorem"

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In the introduction author explained both classical and quantum versions of Bell-CHSH inequalities and clarified how they contradict. The details are mostly taken from the reference [8]. In section 2, in the first case expectation values are taken as scalars and in the second case these values are assumed to be vectors and it has been shown scalar values gives the value

$$\mathrm{E}\,(\mathrm{AB}) + \mathrm{E}\,(\mathrm{AB}') + \mathrm{E}\,(\mathrm{A}'\mathrm{B}) - \mathrm{E}\,(\mathrm{A}'\mathrm{B}') \leq 2$$

and the vector values yield

$$\mathrm{E}\,(\mathbf{AB}) + \mathrm{E}\,(\mathbf{AB}') + \mathrm{E}\,(\mathbf{A}'\mathbf{B}) - \mathrm{E}\,(\mathbf{A}'\mathbf{B}') \leq 2\sqrt{2}$$

and thus there is a contradiction. The main assumption of the article is that the expectation values are taken as vectors (the second case). Author argued that the classical and quantum approaches are simply differentiated by identifying expectation values of outcomes as scalars and vectors respectively. In general, Bell's theorem in the CHSH version is based on the assumption that the expectation values of the quantities A, A′, B, B′ are scalars, not vectors. However, author argued that an alternative of considering expectation values of the quantities A, A′, B, B′ as vectors and such alternative is motivated by the assumption that the values of the components of spin are indeed vectors. Further, the detailed arguments are quite interesting.

The main question is whether the expectation values be taken as unit vectors. In general, the expectation value of any quantity is a scalar. We write

$$E(A) = \boldsymbol{a}.\boldsymbol{\sigma}$$

that is projection of **a** on the vector **sigma** and

$$E(AB) = (\boldsymbol{a}.\boldsymbol{\sigma})(\boldsymbol{b}.\boldsymbol{\sigma}) = -\boldsymbol{a}.\boldsymbol{b} = -cos\theta_{ab}$$

.Thus, we have the expectation values are always scalars. We indeed get

$$\mathrm{E\,(AB)\; + \;E\,(AB') \; + \; E\,(A'B) - E\,(A'B')} \leq 2\sqrt{2}$$

If we simply assume E(A)=**a** (or E(**A**)=**a**) and E(B)=**b** and writing E(AB)=**a.b** gives scalar without negative. But in the article, it is assumed as E(AB)=**ab** (or E(**AB**)=**ab**) without any product symbol between vectors. If we assume it as a scalar product with negative sign then only, we get the desired result other wise not. Mathematically, writing vectors side by side gives a geometric product

$$\boldsymbol{ab} = \boldsymbol{a}.\boldsymbol{b} + \boldsymbol{a} \wedge \boldsymbol{b}$$

and the magnitude is

$$|\boldsymbol{ab}| = (cos^2\theta_{ab} + sin^2\theta_{ab})^{1/2}$$

In that case also we may get the result

$$\mathrm{E\,(AB)\; + \;E\,(AB') \; + \; E\,(A'B) - E\,(A'B')} \leq 2$$

Then we have to represent E(AB)=|**ab**| not **ab**.

In (5) the LHS is represented by |**b**+**b**'| +|**b**-**b**'|. It means the author must be assuming the expectation value as a modulus of a vector which is a scalar indeed.

The author calculates the RHS in (7) as

$$-2\sqrt{2}$$

In that case he may be assuming the product**ab** as **a.b** and therefore we get negative before

$$2\sqrt{2}$$

In (8), RHS is expressed as

$$\pm 2\sqrt{2}$$

How we get this from (7) is not known and the argument below (8) is quite obscure.

Finally, the assumption of replacing scalars by vectors is the question that remains.

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