Not all local-realistic theories are forbidden by Bell's theorem

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Abstract

Bell's theorem prescribes that no theory of nature that obeys locality and realism can reproduce all the predictions of quantum theory. However Bell's theorem presupposes that particles which are distanced from each become *spatially disconnected*. However, the possibility of *spatial-locality* between distanced particles has never been confirmed experimentally. Here I show that an infinite set of local-deterministic relativity theories which violate Lorentz's contraction for distancing bodies, cannot be forbidden by Bell's theorem. This in itself cannot guarantee that a theory from this set of theories will be successful in reproducing the predictions of quantum theory, but until the spatial-locality loophole is satisfactorily closed, the fate of such theories should be decided by experiments.

Keywords: Bell's Theorem, Entanglement, Relativity, Locality, Realism. Lorentz Invariance.

Bell's theorem[1-2] prescribes that no theory of nature that obeys locality and realism can reproduce all the predictions of quantum theory. However Bell's theorem presupposes that particles which are distanced from each become *spatially disconnected*. However, the possibility of spatial-locality between distanced particles has never been verified. Here I demonstrate that an infinite number of local-realistic theories, predicting that spatial-locality between distancing bodies could be sustained, are conceivable. For this purpose consider a system in which two particles A and B distance from each other along the +*x* axis with normalized constant velocity β. Denote the radius of particle B in its rest-frame by Δx^0.

For an inertial system, as the one described above, the relativistic distance transformation is given by:

$$\Delta x = \Lambda_x(\beta)\, \Delta x^0 \qquad \dots (1)$$

Where Δx is the length of particle B along the x-axis in the reference-frame of particle A, and $\Lambda_x(\beta)$ is the distance's transformation factor. Now consider the set of all continuous and well behaved local and deterministic relativity theories, in which $\Lambda_x(\beta)$ satisfies the following conditions:

$$\Lambda_x(0) = 1 \qquad \dots. (2)$$

$$\frac{\partial \Lambda_x(\beta)}{\partial \beta} \geq 0, \text{ for } \beta \geq 0, \text{ and } \frac{\partial \Lambda_x(\beta)}{\partial \beta} < 0, \text{ for } \beta < 0 \quad \text{.... (3)}$$

$$\Lambda_x(\infty) = \infty \quad \text{.... (4)}$$

The condition in (2) ensures the invariance of Δx^0 if the two particles are stationary with respect to each other. The conditions in (3) and (4), contrary to the Lorentz contraction, prescribe that the spatial dimension Δx^0 of particle B, along its movement relative to particle A, will continually "stretch" with β, approaching ∞ as β approaches ∞. Since the Lorentz Invariance contradicts with quantum theory itself [3-4], its violation by conditions (3) and (4) (for distancing bodies) is difficult to object.

In theories of the above defined type, local entanglement becomes feasible even when temporal-locality has been eliminated[5-9]. It is easily noticed that for any distance *d* between A and B, conditions (1)-(4) guarantee the existence of a critical velocity $\beta^*(d)$, above which the *relativistic stretch* of particle B in A's frame is larger than *d*.

It is noteworthy that the type of distance transformation discussed above, correlates with the Doppler Effect[10] observed for waves emitted from moving bodies. This correlation suggests that redshift data from receding galaxies could be used not only to infer about their recession velocities, but also about their spatial dimensions and mass densities.

In summary, it is argued that Bell's theorem does not pay regard to a possible spatial-locality between distanced particles, and that tests of the theory were only successful in closing the loophole of temporal-locality, leaving the loophole of spatial-locality wide open. Moreover, it was demonstrated that an infinite set of local-deterministic relativity theories, which violate Lorentz's contraction for distancing bodies, cannot be forbidden by Bell's theorem. This in itself cannot guarantee that a theory in this set of theories will be successful in reproducing the predictions of quantum theory, but until the spatial-locality loophole is satisfactorily closed, the fate of such theories should be decided by experiments.

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