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Quantum correlations in Newtonian space and time: arbitrarily fast communication or nonlocality

Experimental violations of Bell inequalities using space-like separated measurements precludes the explanation of quantum correlations through causal influences propagating at subluminal speed. Yet, “everything looks as if the two parties somehow communicate behind the scene". We investigate the assumption that they do so at a speed faster than light, though finite. Such an assumption doesn't respect the spirit of Einstein relativity. However, it is not crystal clear that such “communication behind the scene" would contradict relativity. Indeed, one could imagine that this communication remains for ever hidden to humans, i.e. that it could not be controlled by humans, only Nature exploits it to produce correlations that can't be explained by usual common causes. To define faster than light hidden communication requires a universal privileged reference frame in which this faster than light speed is defined. Again, such a universal privileged frame is not in the spirit of relativity, but it is also clearly not in contradiction: for example the reference frame in which the cosmic microwave background radiation is isotropic defines such a privileged frame. Hence, a priori, a hidden communication explanation is not more surprising than nonlocality.
We prove that for any finite speed, such models predict correlations that can be exploited for faster-than-light communication. This superluminal communication doesn't require access to any hidden physical quantities, but only the manipulation of measurement devices at the level of our present-day description of quantum experiments. Consequently, all possible explanations of quantum correlations that satisfy the principle of continuity, which states that everything propagates gradually and continuously through space and time, or in other words, all combination of local common causes and direct causes that reproduce quantum correlations, lead to faster than light communication. Accordingly, either there is superluminal communication or the conclusion that Nature is nonlocal (i.e. discontinuous) is unavoidable [Nature Physics 8, 867-70, 2012; arXiv:1210.7308].

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