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The Relativity of Colocality is the Ghost of Quantum Non-Locality

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NONLOCALITY: Despite numerous exquisite experimental verifications of quantum (Bell) nonlocality (1), Bell's insights have not led to any new consensus for the ontology of spacetime. This is problematic because there are serious conceptual difficulties in reconciling nonlocal EPR correlations with the metric properties of Minkowskian 4D spacetime. Simply, how is nonlocality sustainable within a local spacetime? I address this conflict by arguing for a series of remarkable parallels between the 'Relativity of Colocality'(2) and quantum nonlocality (QNL). These parallels point to a quantum-friendly spacetime ontology.

RELATIVITY OF COLOCALITY (RoC): This encapsulates the simple fact that inertial observers disagree on the colocality of events. The relativity of colocality (2) is the dual phenomenon to the relativity of simultaneity. This duality arises from the x <–> ct symmetry of the Lorentz boost transformation.

PARALLELS: Let us consider two scenarios: A) an entangled pair of EPR particles, subject to Bell; B) an ensemble of classical inertial observers, subject to the RoC. On the surface, these are quite different systems, yet there are remarkable parallels. The key step is to analyze the ensemble of all observers, not isolated individuals. I will show the following: both scenarios involve a form of spatial correlation (unattenuated by spatial separation); both forms of correlation are no-signalling and avoid causality violation; both involve inseparable events which (in suitable senses) are not localized; and both find a means to render the spacetime interval irrelevant. Such unprecedented kinship with Bell nonlocality demands explanation.

CONCLUSION: The primary purpose of this presentation is to argue that for an ensemble of classical inertial observers, Einstein's special relativity contains unmistakable echoes of quantum nonlocality. This correspondence opens the door to a new approach to quantum spacetime.

[1] Nicolas Brunner et al. "Bell nonlocality". In: Rev. Mod. Phys. 86 (2 Apr. 2014), pp. 419–478. DOI: 10.1103/RevModPhys.86.419.
[2] J. C. Sharp. "Symmetry of the Lorentz boost: the relativity of colocality and Lorentz time contraction". In: European Journal of Physics 37.5 (2016), p. 055606.

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