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Bell's Nonlocality in a General Nonsignaling Case: Quantitatively and Conceptually

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Abstract Quantum violation of Bell inequalities is now used in many quantum information applications and it is important to analyze it both quantitatively and conceptually. In the present paper, we analyze violation of multipartite Bell inequalities via the local probability model—the LqHV (local quasi hidden variable) model (Loubenets in J Math Phys 53:022201, 2012), incorporating the LHV model only as a particular case and correctly reproducing the probabilistic description of every quantum correlation scenario, more generally, every nonsignaling scenario. The LqHV probability framework allows us to construct nonsignaling analogs of Bell inequalities and to specify parameters quantifying violation of Bell inequalities—Bell's nonlocality—in a general nonsignaling case. For quantum correlation scenarios on an N-qudit state, we evaluate these nonlocality parameters analytically in terms of dilation characteristics of an N-qudit state and also, numerically—in d and N. In view of our rigorous mathematical description of Bell's nonlocality in a general nonsignaling case via the local probability model, we argue that violation of Bell inequalities in a quantum case is not due to violation of the Einstein–Podolsky–Rosen (EPR) locality conjectured by Bell but due to the improper HV modelling of "quantum realism".

Keywords Nonsignaling · Bell's nonlocality · The LqHV modelling · Quantum realism

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