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Nonsignaling as the consistency condition for local quasi-classical probability modeling of a general multipartite correlation scenario

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Abstract

We specify for a general correlation scenario a particular type of local quasi hidden variable (LqHV) model (Loubenets 2012 *J. Math. Phys.* **53** 022201)—a deterministic LqHV model, where all joint probability distributions of a correlation scenario are simulated via a single measure space with a normalized bounded real-valued measure not being necessarily positive and random variables, each depending only on a setting of the corresponding measurement at the corresponding site. We prove that an arbitrary multipartite correlation scenario admits a deterministic LqHV model if and only if all its joint probability distributions satisfy the consistency condition, constituting the general nonsignaling condition formulated in Loubenets (2008 *J. Phys. A: Math. Theor.* **41** 445303). This mathematical result specifies a new probability model that has a measure-theoretic structure resembling the structure of the classical probability model but incorporates the latter only as a particular case. The local version of this *quasi-classical probability model* covers the probabilistic description of each nonsignaling correlation scenario, in particular, each correlation scenario on a multipartite quantum state.

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1. Introduction

A possibility of the description of quantum measurements in terms of the classical probability model has been a point of intensive discussion ever since the seminal publications of von Neumann [1], Kolmogorov [2], Einstein, Podolsky and Rosen (EPR) [3] and Bell [4, 5].

Although, in the quantum physics literature, one can still find the misleading[1] claims on a peculiarity of 'quantum probabilities' and 'quantum events', the probabilistic description of each quantum measurement satisfies the Kolmogorov axioms [2] for the theory of probability.

[1] On the misleading character of such statements, see also [6].