Found Phys (2015) 45:840–850
DOI 10.1007/s10701-015-9903-8

Context-Invariant and Local Quasi Hidden Variable (qHV) Modelling Versus Contextual and Nonlocal HV Modelling

Elena R. Loubenets[1]

Received: 19 January 2015 / Accepted: 10 April 2015 / Published online: 21 April 2015

Abstract For the probabilistic description of all the joint von Neumann measurements on a D-dimensional quantum system, we present the specific example of a context-invariant quasi hidden variable (qHV) model, proved in Loubenets (J Math Phys 56:032201, 2015) to exist for each Hilbert space. In this model, a quantum observable X is represented by a variety of random variables satisfying the functional condition required in quantum foundations but, in contrast to a contextual model, each of these random variables equivalently models X under all joint von Neumann measurements, regardless of their contexts. This, in particular, implies the specific local qHV (LqHV) model for an N-qudit state and allows us to derive the new exact upper bound on the maximal violation of $2\times\cdots\times2$-setting Bell-type inequalities of any type (either on correlation functions or on joint probabilities) under N-partite joint von Neumann measurements on an N-qudit state. For d = 2, this new upper bound coincides with the maximal violation by an N-qubit state of the Mermin–Klyshko inequality. Based on our results, we discuss the conceptual and mathematical advantages of context-invariant and local qHV modelling.

Keywords qHV modelling · Nonclassicality · Contextuality · Quantum nonlocality · Bell-type inequalities

1 Introduction

In quantum theory, the interpretation of von Neumann [1] measurements via the probability model[1] of the classical statistical mechanics, that is, in terms of random variables

[1] In the mathematical physics literature, this probability model is often named after Kolmogorov. However, in the probability theory literature, the term "Kolmogorov model" is mostly used [2] for the Kolmogorov probability axioms [3]. These axioms hold for a measurement of any nature, in particular, quantum, see also our discussion in [4,5].

✉ Elena R. Loubenets
erl@erl.msk.ru

1 Moscow State Institute of Electronics and Mathematics, Moscow 109028, Russia