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Full Bell locality of a noisy state for $N \geqslant 3$ nonlocally entangled qudits

Elena R Loubenets

National Research University Higher School of Economics, Moscow, 101000, Russia

E-mail: elena.loubenets@hse.ru

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Abstract

Bounds, expressed in terms of d and N, on *full Bell locality* of a quantum state for $N \geqslant 3$ nonlocally entangled qudits (of a dimension $d \geqslant 2$) mixed with white noise are known, to our knowledge, only within full separability of this noisy N-qudit state. For the maximal violation of general Bell inequalities by an N-partite quantum state, we specify the analytical upper bound expressed in terms of dilation characteristics of this state, and this allows us to find new general bounds in d, N, valid for all $d \geqslant 2$ and all $N \geqslant 3$, on *full Bell locality* under generalized quantum measurements of (i) the N-qudit GHZ state mixed with white noise and (ii) an arbitrary N-qudit state mixed with white noise. The new full Bell locality bounds are beyond the known ranges for full separability of these noisy N-qudit states.

Keywords: noisy N-qudit states, full Bell locality, LqHV modelling

1. Introduction

Quantum nonlocality is now used in many quantum information processing tasks and though, in more than 50 years since the seminal papers [1, 2] of Bell, there is still no a unique conceptual view[1] on this notion, it is nowadays clear that quantum nonlocality does not mean propagation of interaction faster than light and is not [4] equivalent to quantum entanglement. Moreover, in quantum information, nonlocality of a multipartite quantum state is defined purely mathematically—via *violation by this state of a Bell inequality*, and it is specifically in this context quantum nonlocality is now used in experimental tasks and is discussed in the present article.

In applications, one, however, deals with noisy channels and, for a nonlocal N-partite quantum state, it is important to evaluate amounts of noise breaking the nonclassical character of its statistical correlations. Note that *full Bell locality* of an N-partite quantum state, in the

[1] On conceptual and quantitative issues of Bell's nonlocality see the recent article [3] in *Foundations of Physics* and references therein.