Detecting quantum correlations by means of local noncommutativity

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Quantum correlation is a key to our understanding of quantum physics. In particular, it is essential for the powerful applications to quantum information and quantum computation. There exist quantum correlations beyond entanglement, such as quantum discord (QD) and measurement-induced nonlocality (MiN) [Phys. Rev. Lett. \textbf{106}, 120401(2011)]. In [Phys. Rev. A \textbf{77}, 022113 (2008)], a subclass of PPT states so-called strong positive partial transposition (SPPT) states was introduced and it was conjectured there that SPPT states are separable. However, it was illustrated with examples in [Phys. Rev. A \textbf{81}, 064101(2010)] that this conjecture is not true. Viewing the original SPPT as SPPT up to part B, in the present paper, we define SPPT state up to part A and B respectively and present a separable class of SPPT states, that is the super SPPT (SSPPT) states, in terms of local commutativity. In addition, classical-quantum (CQ) states and nullity of MiN are characterized via local commutativity. Based on CQ states, the geometric measure of quantum discord (GMQD) for infinite-dimensional case is proposed. Consequently, we highlight the relation among MiN, QD(GMQD), SSPPT and separability through a unified approach for both finite- and infinite-dimensional systems: zero MiN implies zero QD(GMQD), zero QD(GMQD) signals SSPPT and SSPPT guarantees separability, but the converses are not valid.

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