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学术论文

高维双体量子系统的LQU下界

Lower bound of local quantum uncertainty for high-dimensional bipartite quantum systems

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1 Background

- One hundred years on, quantum superposition and entanglement have proven to be some of the most groundbreaking concepts in physics. However, some states without entanglement possessing quantum correlations can still reveal their power in quantum speed-up. Nowadays, it is widely believed that the non-classical correlations, i.e., quantum correlations play a vital role in terms of quantum features in quantum information processing.
- Similar to quantum entanglement, the quantitative measurement of quantum correlations is of great importance.

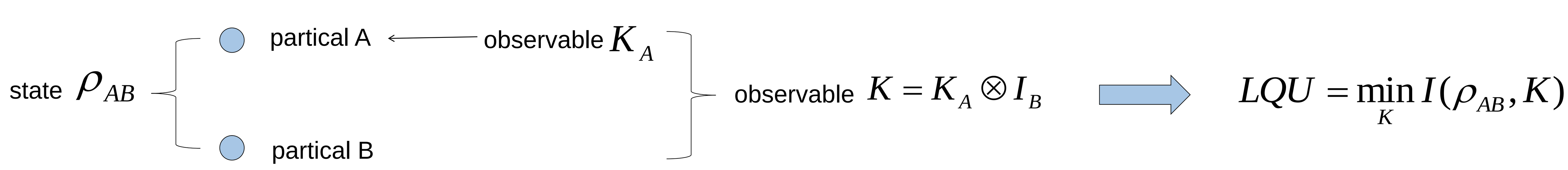
2 Motivation

Local quantum uncertainty (LQU) was proposed recently as an crucial measurement of quantum correlations for bipartite quantum systems. The calculation of LQU is considerably difficult, so we try to obtain a closed-form lower bound of LQU for high-dimensional quantum systems.

3 Our work

- **Lower bound of LQU**

In a $d_1 \times d_2$ quantum system, the LQU is the minimum skew information with a fixed spectrum:



The difficulty lies in the parametrization of these operators of A. Making use of the construction of qubit operators $K_A^\alpha = s \cdot \lambda + \beta I_{d_1}$, we proved:

Theorem: The closed-form lower bound of the LQU for a $d_1 \times d_2$ quantum states is

$$LQU_A = \alpha^2 \left(\frac{2}{d_1} - \lambda_{\max}(W) \right)$$

where W is some matrix derived from the non-degenerate fixed spectrum.

- **Lower bound vs. optimized LQU**

We chose some qutrit-qutrit and qudit-qubit states, and compared the lower bound of LQU with the optimized LQU which was obtained by the genetic algorithm. The numerical evaluations

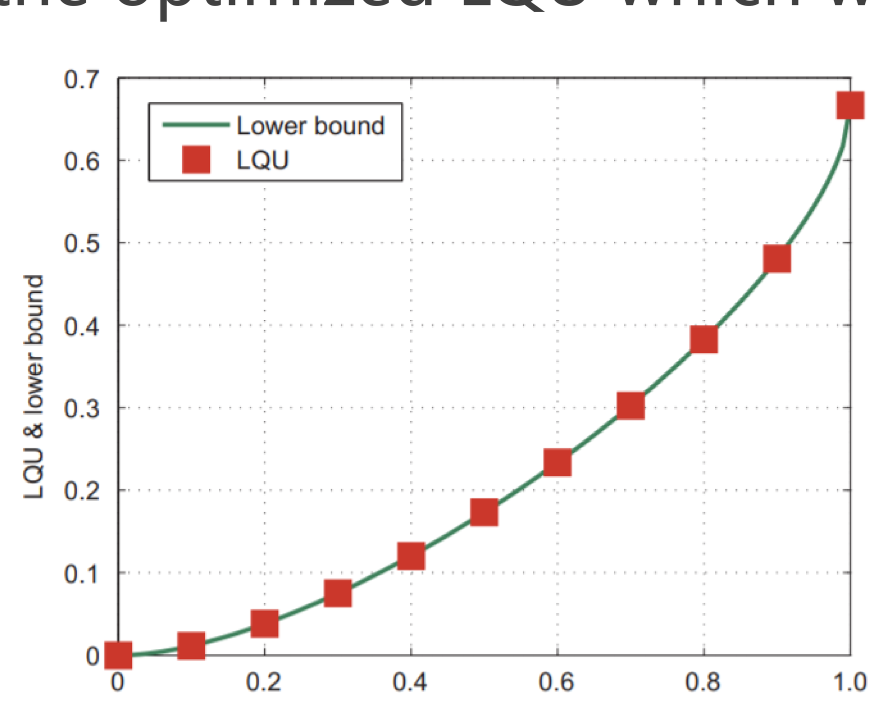


Figure 1 (Color online) LQU of the qutrit-qutrit isotropic state.

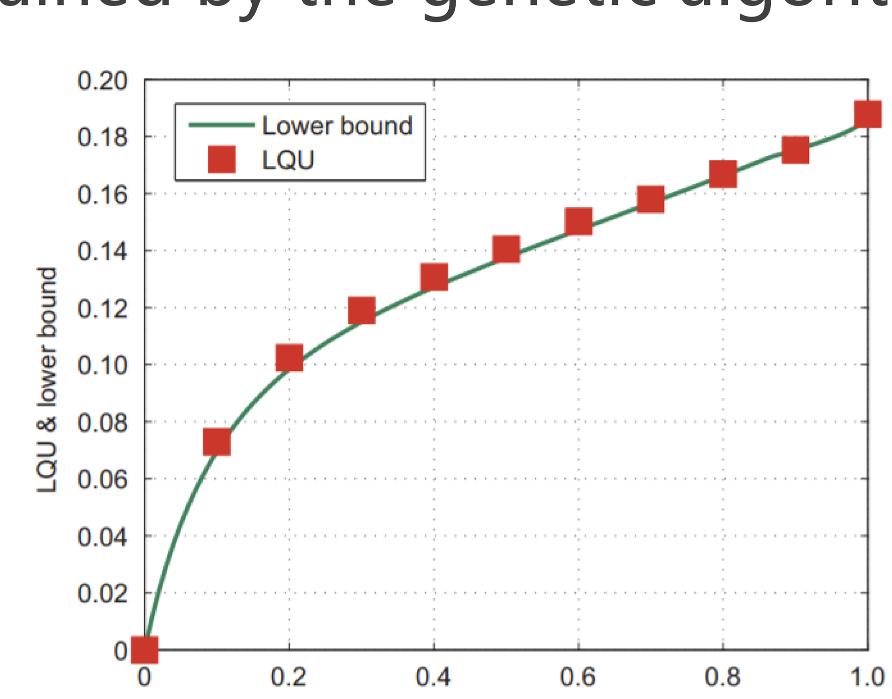


Figure 2 (Color online) LQU of the qutrit-qutrit Horodecki state.

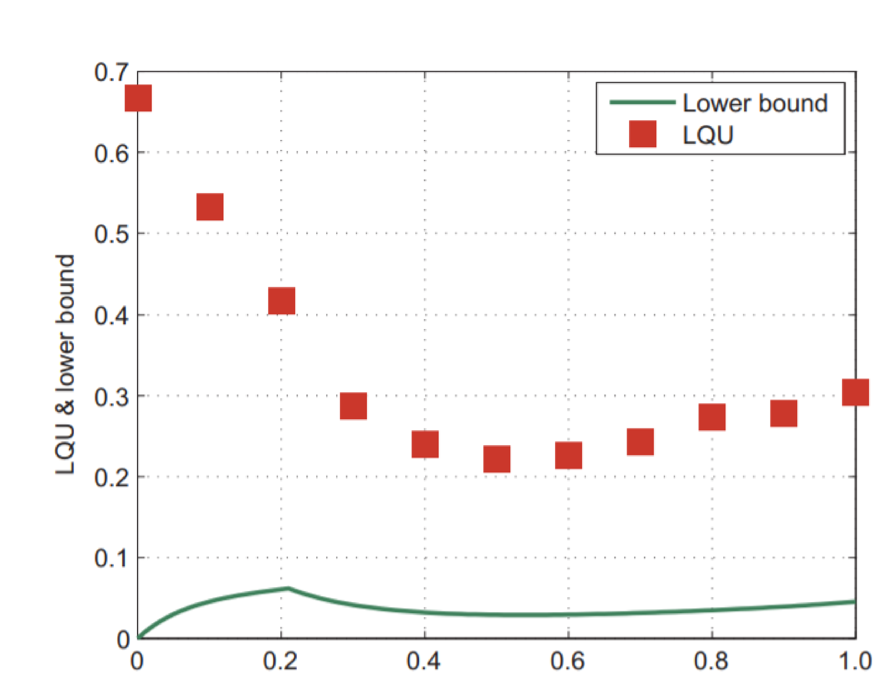


Figure 5 (Color online) LQU of the 4×2 Horodecki state.

revealed that: in 3d quantum systems the freedom of the operator spectrum is relatively small, the lower bound is tight against the optimized LQU; as the dimension grows, the freedom of the operator spectrum increases, the lower bound is much lower than the optimized LQU.