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Quantum discord based on linear entropy and thermal entanglement of qutrit-qubit spin chain under influence of the external magnetic field

Quantum entanglement plays important roles in many areas of quantum information processing (QIP). Nevertheless, quantum entanglement is not the only form of quantum correlation that is useful for QIP. In fact, some separable states may also speed up certain quantum tasks, relative to their classical counterparts. Example of such quantum correlations, is a quantity, called quantum discord (QD), which can effectively capture all quantum correlations present in various kinds of quantum systems. The quantum discord involves a minimization procedure that is difficult to solve in general. To overcome the difficulty encountered with the computability of quantum discord based on von Neumann entropy, we propose a reliable analytical method to evaluate the quantum discord based on linear entropy for an arbitrary qudit-qubit quantum state. The quantum discord based on linear entropy is employed to derive the amount of quantum correlations in a qutrit-qubit mixed spin system in the thermal equilibrium at temperature T. We investigated also the situation when the system is embedded in an external magnetic field B. The obtained amount of quantum discord is then compared with the measurement-induced disturbance (MID) and logarithmic negativity (LN). The results for B = 0 are shown in (Fig.1). The analysis shows that the quantum discord based on the linear entropy behaves like measurement induced disturbance. This indicates that this variant of quantum discord is a useful tool to deal with quantum correlations between multi-component systems of higher dimensional Hilbert spaces. Besides, both QD and MID are robust than thermal entanglement against the temperature T. Further, QD and MID are able to detect the critical points of transition QPT, while the logarithmic negativity cannot provide such indication.

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