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Describing quantumness of qubits and qutrits by Wigner function's negativity

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According to modern views, the Wigner quasiprobability distribution provides a qualitative information on many quantum phenomena occurring in diverse physical systems. The Wigner function has all the properties of statistical distributions except one: taking negative values for some quantum states, the Wigner function turns to be not a proper distribution, and hence it indicates the existence of truly quantum features which cannot be described within the classical statistical paradigm. Deviation of the Wigner quasiprobability distribution from a proper statistical distribution of a physical system is interpreted as an evidence of non-classicality, or quantumness. In this report, based on the recently elaborated method of construction of the Wigner function of a finite dimensional system, we will discuss the following measures/indicators for quantification of non-classicality of a finite-dimensional system: 1. The negativity probability defined for an arbitrary ensemble of a random quantum state as the ratio of the number of states with negative Wigner functions to the total number of generated states. 2. KZ-indicator introduced by A. Kenfack and K. Zyczkowski and defined as an integral over the phase-space manifold of the absolute value of the Wigner function. 3. Global indicator of non-classicality defined as the ratio of the volume of orbit space of a state space with non-negative Wigner function to the volume of total orbit space. It is assumed that the volume is calculated with respect to a Riemannian metric induced by mapping of a state space to the orbit space. All the above mentioned non-classicality measures will be exemplified by considering the Hilbert-Schmidt ensemble of qubits and qutrits.

Summary

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