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Distinguishing generic quantum states

Properties of random mixed states of dimension N distributed uniformly with respect to the Hilbert-Schmidt measure are investigated. We show that for large N, due to the concentration of measure phenomenon, the trace distance between two random states tends to a fixed number $1/4+1/\pi$, which yields the Helstrom bound on their distinguishability. To arrive at this result we apply free random calculus and derive the symmetrized Marchenko–Pastur distribution. Asymptotic value for the root fidelity between two random states, $\sqrt{F}=3/4$, can serve as a universal reference value for further theoretical and experimental studies. Analogous results for quantum relative entropy and Chernoff quantity provide other bounds on the distinguishability of both states in a multiple measurement setup due to the quantum Sanov theorem. Entanglement of a generic mixed state of a bi–partite system is estimated.