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Quantum chaotic behaviour of dynamical discord

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Chaos in classical systems is characterized by extreme sensitivity of the dynamics to small perturbations. A corresponding characterization at the quantum level is challenging due to the uncertainty principle and the unitarity of quantum evolution. Here we explore how chaos can manifest itself in the quantum correlations between a collection of spin-1/2 systems or qubits. We present the first evidence of signatures of chaos in the dynamics of quantum discord in the multiqubit system, which is collectively modelled as a kicked top. The evolution of discord between any two qubits is quasiperiodic in regular regions, while in chaotic regions, the quasiperiodicity is lost. As the initial wave function is varied from the regular regions to the chaotic sea, a contour plot of the time averaged-discord clearly reproduces the structures of the classical stroboscopic map. We also find surprisingly opposite behaviour of two-qubit discord versus two-qubit entanglement. Our calculations show that unlike two-qubit entanglement, two-qubit discord is robust in the presence of a chaotic environment. Our results provide new insight into the effect of chaos on quantum correlations and are of relevance for the design of protocols involving multiqubit systems in noisy environments.

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