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Searching for Symmetry Beyond Parity in the Two-Qubit Dicke Model

We try to classify the spectrum of the two-qubit Dicke model by calculating two quantum information measures of its eigenstates: the Wootters concurrence and the mutual quantum information. We are able to detect four spectral sets in each parity subspace of the model, which may attest to the existence of a symmetry or partial symmetry in the model. One of these sets is regular and given by the product of a Fock state of the field and the singlet Bell state of the qubits; the rest are fairly regular and related to the triplet states of the Bell basis. The singlet states become trapping states when we couple the Dicke model to an environment of harmonic oscillators, making them candidates for generating maximally entangled states in experimental realizations of ion trap quantum electrodynamics (QED) and circuit QED. Furthermore, they are robust and survive the inclusion of driving and dipole-dipole interactions, pointing to their use for storing quantum correlations.

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