Anticoherence of multiqubit symmetric states

In a spin-j system, spin-coherent states are the closest to classical states with a spin pointing in a well defined direction. As opposed to this, anticoherent states are characterized by a vanishing spin expectation value and can be viewed as the most non-classical spin states. In a recent work [1], we have shown that anticoherent states are equivalent to maximally entangled symmetric states. Such states have attracted growing attention in the literature and appear under various names such as normal forms, hidden polarization states or non-generic states [1].

A spin-j state is said to be anticoherent to order t if $\langle(\hat{\mathbf{J}}\cdot\mathbf{n})^k\rangle$ is independent of $\mathbf{n}$, a unit vector, for $k = 1, \ldots, t$ [2]. Using Majorana's representation for spin states, this definition can be transposed to symmetric states of $N \equiv 2j$ qubits and leads to novel interpretations of anticoherence [1, 3]. We have shown that an N-qubit symmetric state is anticoherent to order t iff its t-qubit reduced density matrix is proportional to the identity. Anticoherent states are necessarily entangled as all anticoherent states maximize the Meyer-Wallach entanglement measure and any entanglement monotone based on linear homogenous positive functions of pure state within their SLOCC classes [4, 5] of states. It is therefore important to identify those states as they can serve as a useful resource in many different contexts.

In this work, we provide general conditions, either based on the Husimi function or the Dicke coefficients, for a symmetric state with an arbitrary number of qubits to be anticoherent to any order. We give a nonexistence criterion allowing us to know immediately whether SLOCC classes of symmetric states can contain anticoherent states or not. We show in particular that the symmetric Dicke state SLOCC classes never contain such states, with the only exception of the balanced Dicke state class for even numbers of qubits. We analyze the 4-qubit system exhaustively and identify and characterize all anticoherent states of this system.

References

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