THREE-QUBIT SYSTEM AND QUANTUM CORRELATIONS

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We consider a system of three mutually interacting qubits in which we analyze four families of states in the context of Einstein-Podolsky-Rosen steering, quantum entanglement, and coherence.
To quantify steering effects appearing in two-qubit subsystems we apply the steering parameters S_{ij} based on the Cavalcanti inequality [1]

$$S_{ij} = \langle \hat{a}_i \hat{a}_j^\dagger \rangle \langle \hat{a}_i^\dagger \hat{a}_j \rangle - \langle \hat{a}_i^\dagger \hat{a}_i \left(\hat{a}_j^\dagger \hat{a}_j + \frac{1}{2} \right) \rangle$$

where indices i and j label the qubits, and $\hat{a}^\dagger$, $\hat{a}$ are boson creation and annihilation operators, respectively. If the parameter S_{ij} is positive, qubit j steers qubit i.
We reveal mutual relations among the steering parameter, concurrence, and the coherence of the first and second order. The degree D_{ij} of the first-order coherence between qubits i and j is defined as [2, 3]

$$D_{ij} = \frac{D_i^2 + D_j^2}{2},$$

where D_i is calculated for subsystem i described by one-qubit density matrix ρ_i:

$$D_i = \sqrt{2Tr(\rho_i^2) - 1}.$$

Maximal coherence between qubits i and j manifests by $D_{ij} = 1$, whereas for $D_{ij} = 0$ we do not observe any coherence.
The second-order cross-correlation function is defined by the formula

$$g_{ij}^{(2)} = \frac{\langle \hat{a}_i^\dagger \hat{a}_j^\dagger \hat{a}_i \hat{a}_j \rangle}{\langle \hat{a}_i^\dagger \hat{a}_i \rangle \langle \hat{a}_j^\dagger \hat{a}_j \rangle}$$

that gives for the maximally coherent subsystems $g_{ij}^{(2)} = 1$. No coherence between subsystems i and j results in $g_{ij}^{(2)} = 0$.
In this contribution, we show and discuss analytical formulas that determine the maximal and minimal values of the coherence measures. We show how such measures are related to the values of concurrence (that quantifies the entanglement) of the steerable and unsteerable states.

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