Pairwise Measurement Induced Synthesis of Quantum Coherence

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Quantum coherent superpositions of states with different energies, i.e., states with coherence with respect to energy basis, are important resource for modern quantum technologies. States with small coherence can be obtained either autonomously, due to the effect of a weak coherent drive or, potentially, due to the presence of an environment. Here, we propose a measurement-based protocol for quantum coherence synthesis from individual systems (with low initial coherence) into a global (and higher) coherence of the joint system. As an input, it uses N non-interacting copies of two-level systems (TLS), with low initial energy and coherence. These can be supplied by, e.g., a weak external drive or can result from an interaction with a bath. This protocol conditionally synthesizes an output state with higher energy and coherence than the initial state had, representing an universal process whose rules have not been well studied, yet. In addition to energy and coherence, we study the quantity called mutual coherence, showing increase after the protocol application, as well. This approach is based on application of sequential pairwise projective measurements on TLS pairs (conditionally removing their ground states), that are diagonal in the TLS energy basis. The functionality of the coherence synthesis is robust with respect to dephasing effects of the TLS environment on the system. Our approach may show its benefits in quantum sensing, quantum batteries charging, or other applications where synthesis of a larger coherent system from smaller (weaker) resources is useful.

[1] T. Baumgratz, M. Cramer, and M.B. Plenio, PRL 113, 140401 (2014).

[2] M. Gumberidze, M. Kolář, and R. Filip, Scientific Reports 9, 19628 (2019).