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Decoherence-free subspaces and spontaneous emission cancellation: necessity of Dicke limit K.-P. MARZLIN, IQIS, Univ. of Calgary, Canada, R. KARASIK, Berkeley Quantum Information and Computation Center, and Dept. of Chemistry, Univ. of California, Berkeley, B.C. SANDERS, IQIS, Univ. of Calgary, Canada, K.B. WHALEY, Berkeley Quantum Information and Computation Center, and Dept. of Chemistry, Univ. of California, Berkeley — Decoherence-free subspaces (DFS) of an open quantum system are states for which the coupling to the environment is canceled by destructive interference. DFS are usually studied for states involving two or more particles and are considered a prominent candidate for quantum memory and quantum information processing. Experiments with ions indicate that partial cancellation is possible, but a demonstration of significant cancellation is challenging.

We prove that a perfect physical DFS requires co-located particles, i.e., the Dicke limit. The assumptions made are very general and invoke a homogeneous environment with energy-conserving coupling to the particles. We indicate when a DFS outside the Dicke limit may be possible; this includes molecular and confined systems. Furthermore, we establish a connection between DFS and spontaneous emission cancelation and refine the conditions for one of the important theorems on DFS to hold.

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