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Optimized polarization dynamics through dissipation in a central-spin system ALESSANDRO RICOTTONE, Department of Physics, McGill University, Montreal, Quebec, Canada, YINAN FANG, CAS Key Laboratory of Theoretical Physics, Chinese Academy of Sciences, and University of the Chinese Academy of Sciences, Beijing, China, STEFANO CHESI, Beijing Computational Science Research Center, Beijing, China, WILLIAM COISH, Department of Physics, McGill University, Montreal, Quebec, Canada; Quantum Information Science Program, CIFAR, Toronto, Ontario, Canada — We study the zero-temperature phase diagram and the dissipative dynamics of the central-spin system, where one "central" spin is homogeneously coupled with many "ancilla" spins. An archetypical example of this model is given by an electron spin coupled to nuclear spins in a quantum dot via hyperfine interactions. This same central-spin model has been shown to improve the efficiency of quantum-annealing protocols. We establish the zero-temperature phase diagram with phases characterized by the polarization of the ancilla spins relative to the central spin. By rapidly tuning a parameter in the Hamiltonian, the ancilla-spins polarization can be rapidly modified through a dissipative equilibration process mediated by the central spin. Remarkably, we find that the dissipation rate can be optimized to minimize the time scale for polarization dynamics. These results may be important for protocols to quickly polarize nuclear spins in semiconductor quantum dots or to rapidly and efficiently equilibrate a quantum annealer.

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