MAR12-2011-020179

Abstract for an Invited Paper
for the MAR12 Meeting of
the American Physical Society

Simulating a solid state spin qubit in a spin bath

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Powerful computational methods have been developed in recent years for understanding decoherence induced by environmental spins. Specifically, the cluster correlation expansion [Phys. Rev. B 78, 085315 (2008)] and adaptations [Phys. Rev. Lett. 105, 187602 (2010)] provide successive approximations that approach the solution to the full quantum mechanical problem for small and large spin baths with good efficiency. With these methods, we are able to study the nature of spin-bath decoherence in various regimes, for different types of qubits (e.g., donors or quantum dots) and for different types of spin baths (e.g., nuclei or electrons). Our quantitative analyses have implications for solid state spin qubit prospects and materials choices. Sandia National Laboratories is a multiprogram laboratory operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.