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Anomalous electron spin decoherence in an optically pumped quantum dot[1] XIAOFENG SHI, L.J. SHAM, Department of Physics, University of California San Diego, La Jolla, CA 92093-0319, USA — We study the nuclear-spin-fluctuation induced spin decoherence of an electron (SDE) in an optically pumped quantum dot. The SDE is computed in terms of the steady distribution of the nuclear field (SDNF) formed through the hyperfine interaction (HI) with two different nuclear species in the dot. A feedback loop between the optically driven electron spin and the nuclear spin ensemble determines the SDNF [W. Yang and L. J. Sham, Phy. Rev. B 85, 235319(2012)]. Different from that work and others reviewed therein, where a bilinear HI, $S_\alpha I_\beta$, between the electron (or hole) spin $\mathbf{S}$ and the nuclear spin $\mathbf{I}$ is used, we use an effective nonlinear interaction of the form $S_\alpha I_\beta I_\gamma$ derived from the Fermi-contact HI. Our feedback loop forms a multi-peak SDNF in which the SDE shows remarkable collapses and revivals in nanosecond time scale. Such an anomalous SDE results from a quantum interference effect of the electron Larmor precession in a multi-peak effective magnetic field. In the presence of a bilinear HI that suppresses the nuclear spin fluctuation, the non-Markovian SDE persists whenever there are finite Fermi contact interactions between two or more kinds of nuclei and the electron in the quantum dot.

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Xiaofeng Shi
Department of Physics, University of California San Diego,
La Jolla, CA 92093-0319, USA

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