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Continuous wave noise spectroscopy beyond weak coupling and Markov approximations KYUNGDEOCK PARK, Korea Advanced Institute of Science and Technology, KYLE WILLICK, JONATHAN BAUGH, Institute for Quantum Computing, University of Waterloo — The optimization of dynamical decoupling and error correction for a particular qubit realization relies on accurate noise characterization. Recently probing the spectral density $S(w)$ of semi-classical phase noise by using a spin interacting with continuous-wave (CW) on-resonance field has gained attention. Standard CW noise spectroscopy is designed based on the generalized Bloch equations (GBE) or the filter function formalism assuming weak coupling to the Markovian bath. Under such simplifications, the qubit coherence decays exponentially at a rate proportional to S(Ω) where Ω is the CW field's Rabi frequency. However, naive application of the standard CW protocol can substantially underestimate $S(w)$ at low frequency. We derive the coherence decay function beyond the analysis of the standard CW protocol by extending it to higher orders in the noise strength and discarding the Markov approximation. Simulations show qualitatively that our result is a much improved description of the spin dynamics compared to the simple exponential decay. Exploiting more accurate picture of the spin dynamics, we devise a protocol that extends the range over which $S(w)$ can be reliably reconstructed to beyond the weak coupling and the Markovian regimes.

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