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Dynamical Decoupling with pulse errors for ensembles of interacting spins E. S. PETERSEN, A. M. TYRYSHKIN, S. A. LYON, Princeton University — Dynamical decoupling (DD) is a well-known approach for decoupling quantum (spin) systems from their environments. Theoretically, the performance of DD pulse sequences is often analyzed using a single spin approximation in which environmental noise is included through single spin operators. This approach has successfully analyzed the effectiveness of many popular DD pulse sequences (like CPMG and XY4) to cancel environmental noise even in the presence of unavoidable pulse errors. However, this methodology does not describe the effect of DD on the spin-spin interactions present in experiments involving large numbers of spins. Here, we go beyond the usual single-spin model, extending the analysis of DD sequences to include such spin-spin interactions. We find that when using certain popular DD sequences (like CPMG), coherence times of ensembles with dipolar interactions between spins can be drastically influenced by pulse errors. While sequences with ideal pulses do not decouple the spin-spin interactions, the presence of even small pulse errors can partially (or even greatly) decouple the spin-spin interactions thus leading to longer coherence times. Furthermore, the extent that these interactions are decoupled is highly dependent on the type of DD sequence used, and not necessarily the number of pulses involved. These calculations explain results of past experiments (Tyryshkin et al, arxiv: 1011.1903).

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