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Rigorous demonstration of electron-nuclear decoupling at a spin clock transition[1]

SILAS HOFFMAN, University of Florida

The ability to design quantum systems that decouple from environmental noise sources is highly desirable for development of quantum technologies with optimal coherence. The chemical tunability of electronic states in magnetic molecules combined with advanced electron spin resonance techniques provides excellent opportunities to address this problem. Indeed, so-called clock transitions (CTs) have been shown to protect molecular spin qubits from magnetic noise, giving rise to significantly enhanced coherence. Here we conduct a spectroscopic and theoretical investigation of this physics, focusing on the role of the nuclear bath. Away from the CT, linear coupling to the nuclear degrees of freedom causes a modulation and decay of electronic coherence, as quantified via spin echo signals generated experimentally and in silico. Meanwhile, the effective electron-nuclear interaction vanishes upon approaching the CT, resulting in perfect decoupling and complete absence of quantum information leakage to the nuclear bath, providing opportunities to characterize other decoherence sources.

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