Spin Measurement of Negatively-Charged Defects in Diamond

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Abstract:

Quantum information processing technologies appear to be on the cusp of scalable, fault-tolerant implementation. To reach that goal, in this era of limited (and costly) resources, both our selection of the underlying physical hardware and our control methods must be tailored to maximise benchmark quantities such as operational fidelity.

In this presentation I consider projective spin measurements on three distinct systems: The negatively-charged nitrogen- [1], silicon- [2], and germanium-vacancy [3] centers in diamond. The measurement scheme adopted exploits a dipole-induced transparency in a coupled optical cavity. In this way, the path of an incident photon is entangled with the electronic state of the center, and the expected fidelity between the inferred (pure) and actual (mixed) electronic states becomes the figure of merit.

For the nitrogen-vacancy center, these results [4] build on earlier work [5,6] by considering a more complete energy level structure, and by allowing for the effects of state decay and consequent revival between measurement rounds. For the silicon- and germanium-vacancy centers, to the best of my knowledge this is the first time these quantities have been estimated, prior work achieving measurement via pumped (and perhaps Purcell-enhanced) fluorescence (e.g. [7,8]). I also discuss the impacts of photon bandwidth on pulse times and cavity decay rates, and provide a comparison between single-photon and coherent-light sources.

References:

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