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Coherent Population Trapping of Single Spins in Diamond under Optical Excitation

CHARLES SANTORI, Hewlett-Packard Laboratories, Palo Alto, CA

The nitrogen-vacancy (N-V) center in diamond has long-lived electronic and nuclear spin coherence combined with optical addressability, making it an attractive candidate system for building a photonic network for quantum information applications. However, realizing such schemes will require control over the N-V energy level structure and integration into high-quality microphotonic structures operating at visible wavelengths. In this talk I will describe experiments on optical manipulation of N-V centers in low-nitrogen diamond samples. Typically the optical transitions of NV^- are spin-conserving, so that if the N-V begins in the $m_s=0$ ground state, it can undergo many optical excitation/fluorescence cycles before transitioning to $m_s = \pm 1$. However, by applying stress to the crystal, or by using strain already present, it is possible to realize a Λ -type system with one excited state coupled by optical transitions to multiple ground states. By this technique we have observed coherent population trapping both in N-V ensembles and in single N-V centers. These results demonstrate the potential for all-optical spin manipulation in this system. I will also describe initial work on coupling N-V centers to photonic structures with the goal of enhancing emission into the zero-phonon line, as needed for applications such as quantum repeaters.