Towards Quantum Networks based on color center in diamond

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Implementing efficient, highly controllable light-matter interfaces is essential to realizing the goal of solid-state quantum networks. The nitrogen-vacancy (NV) center in diamond is a promising candidate for such interfaces due to favorable properties, such as long coherence times or single shot readout capabilities. Creating optical links between remote NV centers was an outstanding challenge until the recent demonstration of photon-mediated spin-spin entanglement between NV centers separated by three meters. I will present robust control of two remote NV centers demonstrating Hong-Ou-Mandel interference to verify the indistinguishability of photons produced by remote NV centers. The NV center's application as quantum register depends on the ability to resonantly drive closed cycling transitions and closed lambda transitions with high fidelity. The fidelity can be degraded by phonon-induced mixing within the excited state manifold, which can provide unwanted non-radiative decay channels. I will present detailed investigation of phonon-induced mixing mechanism. Besides the importance to control phonon processes for applications of the NV center in Quantum Information the NV center's broad range of applications as sensors relies on the ability to initialize and readout the electronic state with off-resonant laser light. Both, initialization and read out, rely on an inter-system crossing (ISC) process into a metastable state, a phonon-assisted shelving process that has not been fully explained. We have measured the ISC rate for different excited states and developed a model that unifies the phonon-induced mixing and ISC mechanisms.
Finally, I will give a summary of recent developments with other color centers in diamond, in particular, the Silicon-Vacancy center and the Germanium-Vacancy center in bulk diamond and nanodiamonds and discuss potential applications.

References

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