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Spins and photons: connecting quantum registers in diamond

LILY CHILDRESS, Bates College

Long-lived electronic and nuclear spin states have made the nitrogen-vacancy (NV) defect in diamond a leading candidate for quantum information processing in the solid state. Multi-qubit quantum registers formed by single defects and nearby nuclear spins can currently be controlled and detected with high fidelity. Nevertheless, development of coherent connections between distant NVs remains an outstanding challenge. One advantage to working with solid-state defects is the opportunity to integrate them with microfabricated mechanical, electronic, or optical devices; in principle, such devices could mediate interactions between registers, turning them into nodes within a larger quantum network. In the last few months, several experiments have made key steps toward realizing a coherent quantum interface between individual NV centers using a mechanical quantum bus [1] or optical channels [2,3]. This talk will explore the current state of the art, and report on recent observation of two photon quantum interference between different gate-tunable defect centers [2]. These results pave the way towards measurement-based entanglement between remote NV centers and the realization of quantum networks with solid-state spins.

[1] Kolkowitz et al., Science 335, 1603 (2012)
[2] Bernien et al., Phys. Rev. Lett. 108, 043604 (2012)
[3] Sipahigil et al., http://lanl.arxiv.org/abs/1112.3975