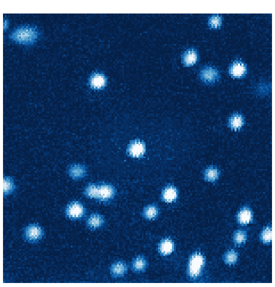
Quantum optical control of a solid-state trapped atom

Monday

November 21

4:00 P.M.

Rm 184 NSH



A constellation of nitrogen-vacancy centers in diamond.

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Although overshadowed by perfect crystalline order in condensed matter pedagogy, defects and impurities in lattices provide an essential means for probing underlying material physics [1] and tailoring material functionality. More recently, the intrinsic quantum mechanical nature of atomic-scale defects in solid-state systems has motivated efforts to build fundamentally new technologies in information processing and sensing. These defects, exemplified by the nitrogen-vacancy (NV) center in diamond, act effectively as 'trapped atoms' within the host semiconductor, as they possess isolated spin and orbital energy levels in the bandgap that can be manipulated by optical, microwave, and mechanical fields. In this talk, I present ongoing efforts in our group to harness coherent optical excitation to demonstrate novel methods to control the quantum states of a single NV center spin. The quantum mechanical Berry phase that arises from adiabatic, cyclic evolution is used to generate geometric spin rotations that are protected from noise in the driving lasers [2]. Furthermore, by judicious shaping of the optical pulses, the purposes of adiabatic evolutions are achieved in shorter times via a 'shortcut' technique that combines both speed and robustness to counteract quantum decoherence and noise [3]. These results illustrate the rich phenomena of quantum physics and contribute to the framework for photonically-controlled solid-state qubits in a quantum network.

[1] B. B. Zhou, S. Misra, et al., Nature Physics 9, 474 (2013).
[2] C. G. Yale, F. J. Heremans, B. B. Zhou, et al., Nature Photonics 10, 184 (2016).
[3] B. B. Zhou, et al., arXiv:1607.06503 (2016). To appear in Nature Physics.