Seminarankündigung

Freitag, 16. August 2019
14:00 Uhr

WSI, Seminarraum S 101

"Quantum coherent interface of an electron and a nuclear ensemble"

Collective excitations of isolated many-body systems generate useful entanglement and offer the opportunity to control ensemble quantum dynamics. A simple quantum system, such as a central spin, can act as a probe and a control over a larger and more complex quantum system in ways otherwise inaccessible, and can help us perform spectroscopy and engineering over its quantum dynamics [1]. Driving the central spin can stimulate exchange of energy with its surrounding spins, and thus modify the mean-field state of its own environment. In our work, we engineer this very interaction between an InGaAs quantum dot electron spin and its isolated ensemble of nuclear spins in a driven-dissipative regime to remove entropic heat from the ensemble, and so vastly reduce the mean-field state uncertainty tied to its thermal fluctuations [2, 3]. Having cooled the system, we perform all-optical electron spin resonance with high fidelity and arbitrary phase control [4]. With enhanced spectral resolution, we reveal an absorption spectrum of transitions between many-body states that are collectively-enhanced by the creation of single spin-wave excitations – nuclear magnons [3]. Resonantly driving such a transition, we stimulate a coherent interaction between the electron and the nuclear spin ensemble, which is consistent with the controlled creation of entanglement among all constituent particles. These results constitute the building blocks of a local dedicated memory [5] for a quantum-dot spin qubit and inaugurate a new solid-state venue for quantum-state engineering of isolated many-body systems.

[1] Taylor et al., "High-sensitivity diamond magnetometer with nanoscale resolution", Nature Physics **4** (2008)

[2] Éthier-Majcher et al., "Improving a Solid-State Qubit through an Engineered Mesoscopic Environment", Physical Review Letters **119** (2017)

[3] Gangloff et al., "Quantum interface of an electron and a nuclear ensemble", Science **364** (2019)

[4] Bodey et al., "Optical spin locking of a solid-state qubit", arXiv:1906.00427 (2019)

[5] Denning et al., "Collective quantum memory activated by a driven central spin", arXiv:1904.11180 (2019)

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