Seminar/Talk

Spin squeezing in an ensemble of nitrogen-vacancy centers in diamond

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Spin squeezed states provide a seminal example of how the structure of quantum mechanical correlations can be controlled to produce metrologically useful entanglement. Such squeezed states have been demonstrated in a wide variety of artificial quantum systems ranging from atoms in optical cavities to trapped ion crystals. By contrast, despite their numerous advantages as practical sensors, spin ensembles in solid-state materials have yet to be controlled with sufficient precision to generate targeted entanglement such as spin squeezing. In this work, we present the first experimental demonstration of spin squeezing in a solid-state spin system. Our experiments are performed on a strongly-interacting ensemble of nitrogen-vacancy (NV) color centers in diamond at room temperature and squeezing (-0.5 pm 0.1 dB) is generated by the native magnetic dipole-dipole interaction between NVs. In order to generate and detect squeezing in a solid-state spin system, we overcome a number of key challenges of broad experimental and theoretical interest. First, we develop a novel approach, using interaction-enabled noise spectroscopy, to characterize the quantum projection noise in our system without directly resolving the spin probability distribution. Second, noting that the random positioning of spin defects severely limits the generation of spin squeezing, we implement a pair of strategies aimed at isolating the dynamics of a relatively ordered sub-ensemble of NV centers. Our results open the door to entanglement-enhanced metrology using macroscopic ensembles of optically-active spins in solids.

Wednesday, February 11, 2026 11:15am - 12:15pm

Office Bldg West / Ground floor / Heinzel Seminar Room (I21.EG.101)

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