北京大学量子材料科学中心

International Center for Quantum Materials, PKU

Seminar

Surpassing the Interaction Limit to Quantum Metrology with Fault-Tolerant Control

Hengyuan Zhou

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Time: 4: 00 pm, June. 10, 2019 (Monday)

时间：2019年6月10日 （周一）下午4:00

Venue: Room W563, Physics building, Peking University

地点：北京大学物理楼，西563会议室

Abstract

Quantum sensing allows the detection of weak magnetic fields with high sensitivity and precision, enabling a myriad of applications ranging from nanoscale nuclear magnetic resonance spectroscopy of biomolecules to local probing of exotic condensed matter phenomena. In principle, the magnetic field sensitivity can be improved by increasing the density of sensors in a given volume; However, beyond a critical density, this improvement in sensitivity is severely hindered by undesirable interactions between the sensors themselves, typically also accompanied by increased inhomogeneity among sensors. Here, using a dense ensemble of interacting electronic spins in diamond, we demonstrate a novel approach to ensemble quantum sensing by designing a leading-order fault-tolerant protocol that simultaneously suppresses interactions, disorder, and imperfect control, while also achieving optimal magnetic field sensitivity. Such fault-tolerant dynamical control of the spin ensemble shows a five-fold enhancement of coherence time compared to conventional methods such as the XY-8 sequence; combined with unconventional spin initializations to fully utilize the effective magnetic field, this leads to a 40% enhancement in magnetic field sensitivity relative to the conventional XY-8 sequence. Our results demonstrate that the sensitivity limit set by interactions and control imperfections can be overcome, opening a promising avenue for the development of nanoscale ensemble magnetometers with unprecedented sensitivity.

About the speaker

Hengyun (Harry) Zhou is currently a graduate student in the group of Prof. Mikhail Lukin at Harvard University, focusing on diamond spin centers as a platform to study many-body physics, and as a tool for various metrology tasks. He is also interested in exploring symmetry and topology in non-Hermitian systems. He did his undergraduate studies at Peking University and MIT.