北京大学量子材料科学中心

International Center for Quantum Materials, PKU

Seminar

Sensing with NV centers in diamond

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Venue: Room w563, Physics building, Peking University

地点：北京大学物理楼，西563会议室

Abstract

Color centers in diamond are popular defects for sensing applications. My group is working on several sensors, including temperature sensors, magnetic field sensors as well as rotation sensors. To this end we use various color center in our research, depending on application. Yet, the main working horse is nitrogen vacancy color center, which allow both vector magnetometry and rotation sensing.

In this work, I will give an overview of our activities on sensing with diamond NV centers, understanding of their interaction with environment and themselves. The interaction of NV center with surrounding unclears spins of carbon 13 as well as with electron spin of substitutional nitrogen are rather well studied in the literature, while interaction of NV centers with themselves is less studied. We performed a systematic study of NV-NV interaction using a dynamical double electron-electron resonance sequence, making it possible to directly observe the interaction of NV centers. Using double electron-electron resonance technique we obtained a complete picture of decoherence due to NV-NV interaction. It was shown that the rate of the state vector decay differed significantly from predictions for a spin ½ system, while still can be observed with double electron-electron based pulse sequences.

I will also emphasize resent advances on coherent manipulation of NV center nuclear spins using coherent population trapping resonance. Although the forbidden resonances required for coherent control were only partially observed, coherent population trapping was successfully demonstrated at both visible and invisible transitions, with an apparent contrast of up to 98 ± 11% and a true contrast of approximately 35 ± 7%. This finding confirms the feasibility of coherent nuclear spin control even in diamond plates with naturally occurring carbon-13. This achievement may find it application in all types of sensors we are currently developing.

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About the speaker

Alexey Akimov received his BS, MS, and PhD degrees from Moscow Institute for Physics and Technology in 1998, 2000, and 2003, respectively. In 1997 he started working in the Laboratory for Active Media at the Lebedev Physical Institute of the Russian Academy of Sciences. His research was focused on the narrow optical resonances in hot and laser-cooled atoms and their applications to metrology. In 2006-2012 he was a visiting scholar in Misha Lukin's group in the Physics Department of Harvard University, where he worked on a number of research projects related to surface plasmons, quantum dots, and NV color centers in diamond. The main focus of this activity was light-spin interfaces and solid state nanophotonics. In 2010-2012 he was the acting director of the Russian Quantum Center (RQC), supported by the Skolkovo Foundation. He then accepted a Principal Investigator position at the RQC and conducted research in the fields of cold atoms and solid-state spin systems. In October 2015 he joined the Physics Department of Texas A&M University as an Assistant Professor. He got his tenue in 2021, but in 2022 returned to Russia where he is now Principal Investigator at Russian quantum center. Since summer 2023 he also serves as the Scientific Director of Russian Quantum Center. Currently his research is covering application of color centers in diamonds in quantum information science, as well as utilization of ultra-cold atoms for quantum simulations.