INVITATION

Department of Condensed Matter Physics

Is pleased to invite you to the lecture

Nuclear spins in semiconductor quantum dots: physics and prospective applications in quantum technologies

by

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Date:	**14 May 2025**
Time:	**11:00**
Venue:	**Lecture room F1, Building 6, Faculty of Science, Kotlářská 2, Brno**

Epitaxial semiconductor quantum dots (QDs) have long been investigated in the context of quantum physics and quantum information processing (QIP). The solid-state nature of the quantum dots poses many challenges. One such challenge comes from the magnetic moments of the atomic nuclei that make up the crystal lattice of a QD. The dense 3D lattice of the nuclear spins often acts as a source of magnetic noise, limiting quantum coherence of the electron and photon qubits. However, introduction of a new generation of low-strain optically-active GaAs/AlGaAs QDs has shifted the paradigm with recent efforts focused on harnessing nuclear spin magnetism as a testbed for fundamental quantum physics and QIP applications. The advances of the past few years include demonstrations of electron [1] and nuclear [2] spin qubits in a semiconductor quantum dot, as well as reversible transfer of quantum states between electron and nuclear spins [3], offering a pathway to implementation of a solid-state quantum memory.

I will discuss recent advanced both in fundamental physics and prospective applications of QD nuclear spins in QIP. Recent findings include an experimental answer to the long-standing dilemma of nuclear spin diffusion in a central-spin model [4]; non-invasive probing of multi-electron states via nuclear spins [5]; ferromagnetic ordering of nuclear spin ensembles, with record-high polarisations exceeding 95% [6]; quantum non-demolition measurement of the central electron spin through entanglement with a nuclear spin ensemble [7], which allows for single-shot qubit readout with fidelities exceeding 99.85%. Moreover, we show how strain-engineering of semiconductor lattice can be used to turn the nuclear spin ensemble into an efficient quantum memory, which can store coherent states for very long times, exceeding 100 ms [8].

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References

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[5] P. Millington-Hotze, *et al.*, arXiv:2504.19257 (2025)
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