Seminar/Talk

Schroedinger cat in a silicon box: quantum information and quantum foundations

Andrea Morello
UNSW Sydney, Australia

Host: Georgios Katsaros/Johannes Fink

I will present recent experiments, and exciting new directions, for the use of high-spin nuclei in silicon for quantum information, quantum foundations, and spin-mechanics entanglement. Nuclear spins in silicon are among the most coherent quantum objects to be found in the solid state. They have infinite relaxation time, and second-scale coherence time [1]. By using the I=7/2, 8-dimensional nucleus of antimony [2], we have prepared a nuclear Schroedinger cat within a functional nanoelectronic device [3]. This can be used to encode a cat-qubit similar to the bosonic encodings used in microwave cavities, but with atomic size, and even more extreme noise bias. Recent work on the simpler phosphorus atoms has shown the ability to entangle nuclear spins that are not bound to the same electron [4]. As the next step for scaling up donor quantum processors, we are working to integrate the donors with lithographic quantum dots, and I will present preliminary results in that direction.We then used the Schroedinger cat and other nonclassical states to perform a curious experiment, where the quantumness of the state is certified by monitoring its uniform precession, in seeming contradiction with Ehrenfest's theorem [4]. High-spin nuclei possess a quadrupole moment that couples them to lattice strain [5]. I will discuss plans to entangle a single nuclear spin with a MHz-range mechanical oscillator, and perspectives to scale up the mass of the oscillator to test gravitational collapse models.[1] J. Muhonen et al., Nature Nanotechnology 9, 986 (2014)[2] S. Asaad, V. Mourik et al., Nature 579, 205 (2020)[3] X. Yu et al., Nature Physics 21, 362 (2025)[4] H. Stemp et al, Science 389, 1234 (2025)[5] A. Vaartjes et al., Newton 1, 100017 (2025)[6] L. O'Neill et al., Applied Physics Letters 119, 174001 (2021)

Thursday, October 2, 2025 03:00pm - 04:00pm
Moonstone Bldg / Ground floor / Seminar Room G (I24.EG.030g)

This invitation is valid as a ticket for the ISTA Shuttle from and to Heiligenstadt Station. Please find a schedule of the ISTA Shuttle on our webpage: https://ista.ac.at/en/campus/how-to-get-here/ The ISTA Shuttle bus is marked ISTA Shuttle (#142) and has the Institute Logo printed on the side.