



Walther-Meißner-Seminar

Walther-Meißner-Institute, Seminar Room 143

Date: Friday, 4 July 2025, 11:15 h

Speaker: **Andrea Morello**

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

Abstract:

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. We used the encoded cat-qubit to demonstrate beyond-break-even quantum error correction, with logic operations that preserve the noise bias.

We then used this and other nonclassical states to perform a curious experiment, where the quantumness of the state is certified by monitoring its uniform precession, challenging the simple view suggested by 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] A. Vaartjes et al., Newton 1, 100017 (2025)

[5] L. O'Neill et al., Applied Physics Letters 119, 174001 (2021)