Universität Münster

Fachbereich Physik

Allgemeines Physikalisches Kolloquium

Donnerstag, 01.02.2024 - 16 Uhr c.t.

Prof. Toeno Van der Sar

TU Delft

Magnetic imaging of spin waves interacting with normal and superconducting metals

Spin waves are collective excitations of the spins in magnetic materials. They play an important role in the thermodynamics of magnets and are promising as signal carriers in classical and quantum information devices. In this talk, I will first introduce spin-wave imaging based on electronic sensor spins in diamond[1,2] – a magnetic resonance technique that enables studying spin waves underneath optically opaque materials[3]. I will then describe experiments on the interaction of spin waves with normal and superconducting metals[4]. For normal metals, Ohmic dissipation dominates the diamagnetic response to the stray magnetic fields of the spin waves, leading to spin-wave damping. In contrast, the dissipationless diamagnetism of superconductors renormalizes the spin-wave dispersion, resulting in spin-wave refraction that is tunable by electric currents, magnetic fields, and temperature. The results indicate that superconductors provide opportunities for realizing tunable, low-damping spin-wave optical devices that could be used for microwave-control in classical or quantum circuits.

(see next page for references and an illustration)

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Kolloquiums-Kaffee ab 16 Uhr vor dem Hörsaal

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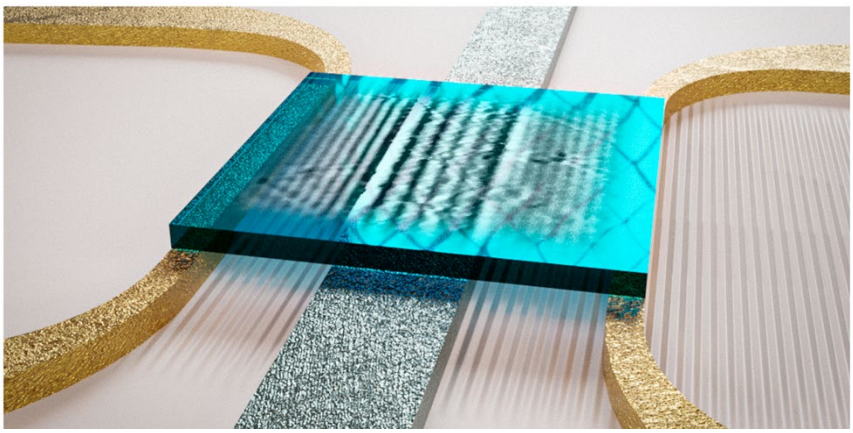

Imaging spin waves underneath a superconducting control electrode using spins in diamond. (Credit: M. Borst)

1. Casola, F., Van Der Sar, T. & Yacoby, A. Probing condensed matter physics with magnetometry based on nitrogen-vacancy centres in diamond. *Nat Rev Mater* **3**, (2018).
2. Bertelli, I. *et al.* Magnetic resonance imaging of spin-wave transport and interference in a magnetic insulator. *Sci Adv* **6**, eabd3556 (2020).
3. Bertelli, I. *et al.* Imaging Spin-Wave Damping Underneath Metals Using Electron Spins in Diamond. *Adv Quantum Technol* **4**, 2100094 (2021).
4. Borst, M. *et al.* Observation and control of hybrid spin-wave–Meissner-current transport modes. *Science* **382**, 430–434 (2023).

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