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Fachbereich Physik, Universität Stuttgart
Max-Planck-Institut für Festkörperforschung
Max-Planck-Institut für Intelligente Systeme

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Scanning SQUID-on-tipnanoscale magnetometry and thermometry

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Abstract

We have recently developed a scanning probe microscope based on superconducting quantum interference device (SQUID) residing on the apex of a nanoscale tip. The SQUID-on-tip is fabricated by pulling a quartz tube into a sharp pipette with diameters down to below 50 nm followed by deposition of a thin superconducting film onto the sides and the apex of the pipette. The devices operate inhigh magnetic fields and display an extremely low flux noise resulting in record spin sensitivity of 0.4 $\mu_B/Hz^{1/2}$ [1]. The combination of high sensitivity, high spatial resolution, wide bandwidth, and close proximity to the sample surface opens the pathway to direct imaging and investigation of a wide range of static and dynamic magnetic phenomena on the nanoscale that will be presented, including study of magnetic topological insulators in the quantum anomalous Hall state.

Remarkably, theSQUID-on-tip can also act as an extremely sensitive thermometer allowing non-contact non-invasive scanning thermal imaging with nanoscale spatial resolution and about four orders of magnitude improved thermal sensitivity of below 1 $\mu K/Hz^{1/2}$. This novel method provides a unique tool for investigation and imaging of dissipation mechanisms in low dimensional systems and topological states of matter. Thermal imaging at dissipation levels below the Landauer dissipation limit for continuous computation of a single qubit and of changes in dissipation due to single electron charging of individual quantum dots in carbon nanotubes will be presented.

[1] D. Vasyukov *et al.*, Nature Nanotech. **8**, 639 (2013).