Universität Basel

Research Project

New Scanning Probes for Nanomagnetic Imaging

Third-party funded project

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Recent years have seen rapid progress in nanometer-scale magnetic imaging technology, with scanning probe microscopy driving remarkable improvements in both sensitivity and resolution. Among the most successful tools are magnetic force microscopy (MFM), spin-polarized scanning tunneling microscopy, as well as scanning magnetometers based on nitrogen-vacancy centers in diamond, Hall-bars, and superconducting quantum interference devices (SQUIDs). Here, we propose the development and application of two particularly promising scanning probe techniques.

The first is scanning SQUID microscopy, which – in its most advanced form – achieves record sensitivity to both stray magnetic flux and local thermal dissipation. Recently, it has been used to study the dynamics of superconducting vortices and to map nanometer-scale transport. In order to extend its applicability and optimize its functionality, we aim to realize a nanometer-scale SQUID integrated on an atomic force microscopy (AFM) tip, producing a **hybrid AFM-SQUID** sensitive to surface forces, stray magnetic flux, and local temperature.

The second is based on newly developed nanowire (NW) force sensors, which have recently enabled a form of AFM capable of mapping both the size and direction of tip-sample forces. Using NWs functionalized with magnetic tips, we intend to realize a form of **vectorial MFM** capable of mapping stray magnetic fields with enhanced sensitivity and resolution compared to the state of the art.

The unique capabilities of these two scanning probes will provide new types of imaging contrast for nanometer-scale magnetic structures such as **domain walls**, **magnetic vortices**, and **magnetic skyrmions**, whose equilibrium configurations and dynamical properties are crucial for both fundamental understanding and spintronic applications. In addition to studying magnetic nanostructures and spin-dependent phenomena, we will apply our newly developed techniques to the study of **mesoscopic current flow in topological insulators and two-dimensional materials**. Further target systems include **superconducting films and nanostructures**, in which our sensitive probes could help clarify the microscopic mechanisms of superconductivity.

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Add publication

Published results

4495363, Rossi, Nicola; Gross, Boris; Dirnberger, Florian; Bougeard, Dominique; Poggio, Martino, Magnetic force sensing using a self-assembled nanowire, 1530-6984 ; 1530-6992, Nano Letters, Publication: JournalArticle (Originalarbeit in einer wissenschaftlichen Zeitschrift)

4511924, Braakman, F. R.; Poggio, M., Force sensing with nanowire cantilevers, 0957-4484, Nanotechnology, JournalItem (Kommentare, Editorials, Rezensionen, Urteilsanmerk., etc. in einer wissensch. Zeitschr.

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