Universität Basel

Research Project

Exploring nanoscale magnetic phenomena using a quantum microscope

Third-party funded project

Project title Exploring nanoscale magnetic phenomena using a quantum microscope
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Project Website www.quantum-sensing.ch
Project start 01.10.2016
Probable end 30.09.2019
Status Completed
Quantum sensors harness quantum phenomena, such as superposition or entanglement to yield powerful sensors for quantities such as electric and magnetic fields, strain fields or temperature. Over the last years, such quantum sensors and in particular magnetometers based on individual spins in diamond have seen remarkable progress, in part based on the successful research and technological developments by the applicant's group at the University of Basel. Todays state-of-the art quantum magnetometers, such as the ones we currently operate in Basel, offer spatial resolutions 10ănm, magnetic field sensitivities up to 20ănT/Hzˆ0.5 and operate from cryogenic to ambient conditions. In this project, we will build on the outstanding performance of our existing magnetometers to address interesting and pressing questions in condensed matter and mesoscopic physics. The performance of our instruments are ideally suited to address these topics in a way impossible with other existing technologies. Our project will on one hand focus on open problems in spintronics and nano-magnetism and on the other hand address challenges in mesoscopic physics of superconductors and low-dimensional electronic systems. Our powerful new technology and the scientific insights it will generate will have far-reaching impact in physics and material sciences and will offer new views on magnetism on the nanoscale. Specifically, we will employ our magnetometers to study high-frequency dynamics in nanoscale magnetic systems. Examples include ferromagnetic resonance and spin-wave propagation that we will both study on the nanoscale. These phenomena are central to spintronics and quantum information processing and our results will thereby contribute to progress in both these fields. In a second line of experiments, we will address mesoscopic, condensed matter systems at cryogenic temperatures. A particular focus will lie on the imaging of current-distributions in superconductors and low-dimensional electronic systems, such as graphene. A broad range of open questions exist in these domains - questions that our NV magnetometers will allow us to address for the first time. We will thereby bring significant new understanding to these diverse aspects of condensed matter physics at the nanoscale.

Financed by
Swiss National Science Foundation (SNSF)

Follow-up project of 1380120 Quantum sensing using single spin microscopy

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