

Post-doc Position Available

Cryogenic Scanning Microwave Microscopy (SMM) of qubits and quantum anomalous Hall effect devices

We seek a talented and ambitious **post-doctoral researcher** interested in applying cryogenic scanning microwave microscopes to image: 1) two-level systems, electric RF fields, and dissipation in superconducting qubits and 2) bulk and edge dielectric constant and loss tangent under different bias voltages, and the effects of film thickness in quantum anomalous Hall (QAHE) effect devices.

Superconducting circuits are a prime candidate platform for the realization of quantum computation. Significant progress has already been made, with demonstrations of quantum circuits containing 10s to 100s of qubits. To make further progress, however, a variety of microscopic effects must be addressed, such as vortex formation, quasi-particle generation, and two-level system defects, which lead to decoherence, as well as detrimental spurious fields, and crosstalk between qubits and control lines. These effects pose significant hurdles for the operation of large quantum circuits. As a result, effort is now dedicated to addressing these challenges via material engineering, fabrication methods, and circuit design. There is a pressing need to guide this work by spatially mapping circuit defects and decoherence mechanisms within quantum circuits.

The quantum Hall effect (QHE) represents the “gold standard” of primary resistance in electrical metrology. However, QHE devices based on GaAs heterostructures require challenging working conditions, i.e., temperature < 1.5 K, magnetic field > 10 T, and currents < 50 μ A. Although the advent of graphene-based devices has relaxed the temperature and magnetic field requirements, it promises only incremental improvements and fails to address the need for operation at smaller magnetic fields, higher critical currents, and the ease of fabrication into large-area device geometries. On the other hand, the discovery of topological quantum materials circumvents the necessity for high magnetic fields and strict control of carrier mobilities. These materials can realize the QAHE at zero magnetic field, independently of carrier mobilities, which could lead to higher critical currents. Additionally, devices are relatively easy to fabricate into large geometries. Further improvements of QAHE devices require the application of advanced scanning microwave microscopy to map defects, edge states and bulk conductivity within the devices.

Highly sensitive scanning microwave microscopy offers a method for addressing both of these questions. Our scanning microwave microscope combines spatial resolution below 100 nm with extremely high sensitivities to electric fields and material parameters that affect the electric field. These quantities are exactly those that play crucial roles in both superconducting circuits and QAHE devices. The projects aim to map these quantities at both 4 K and in a new custom-built scanning probe system operating below 100 mK.

The Department of Physics and the Swiss Nanoscience Institute at the University of Basel offer a stimulating and collaborative environment with internationally recognized research groups active in both experimental and theoretical condensed matter physics. This work is part of the EPM projects QAHMet and MetSuperQ. More information is available at poggilab.unibas.ch.

Post-doc candidates with previous experience on superconducting circuits or low-temperature scanning probe microscopy are preferred. A Ph.D. in physics or a related field is required. Applications should include the candidate's CV and at least 1 letter of reference. Applications and reference letters should be sent directly to Prof. Poggio (martino.poggio@unibas.ch) and Dr. Braakman (floris.braakman@unibas.ch).