O 21: Poster: Scanning Probe Techniques

Time: Monday 18:00–20:00 Location: P2/EG

O 21.1 Mon 18:00 P2/EG

Shot-noise measurements of single-atom junctions using a scanning tunneling microscope — •Verena Caspari, Idan Tamir, Daniela Rolf, Christian Lotze, and Katharina J. Franke — Fachbereich Physik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany

Current passing through small constrictions fluctuates due to the discreteness of charge. Measuring this so-called shot noise in atomic-scale superconducting junctions can provide valuable information, from the quanta of charge transferred in the tunneling process to the correlations of the involved tunneling channels. Here, we use a scanning tunneling microscope equipped with a high-frequency, low-temperature amplifier to measure simultaneously the noise characteristics and the differential conductance of two types of Pb-Pb-junctions having different geometries. The first type is created by deposition and approaching single Pb adatoms, while the second type is established by a break-junction technique. We observe a correlation between the noise pattern and the strength of the Josephson current, independent on the method of junction preparation.

O 21.2 Mon 18:00 P2/EG

A second generation millikelvin scanning tunneling microscope with adiabatic demagnetization refrigeration — Taner Esat[1,2], •Denis Krylov[1], Peter Borgens[1,3,7], Xiaosheng Yang[1,3], Peter Coenen[1,4], Vasily Cherepanov[1,4], Andrea Raccanelli[5,7], F. Stefan Tautz[1,2,3], and Ruslan Temirov[1,6] — [1]Peter Grünberg Institute (PGI-3), Forschungszentrum Jülich, 52425 Jülich, Germany — [2]Jülich Aachen Research Alliance, Fundamentals of Future Information Technology, 52425 Jülich, Germany — [3]Experimentalphysik IV A, RWTH Aachen University, 52074 Aachen, Germany — [4]mProbes GmbH, 52428 Jülich, Germany — [5]Cryovac GmbH & Co KG, 53842 Troisdorf, Germany — [6]Faculty of Mathematics and Natural Sciences, Institute of Physics II, University of Cologne, 50937 — [7]Current address: Peter Grünberg Institute (CryoLab), Forschungszentrum Jülich, 52425 Jülich, Germany

We present the design of a second generation ultra-high vacuum scanning tunneling microscope (STM) that uses adiabatic demagnetization of electron magnetic moments for controlling its operating temperature down to 30 mK. A high degree of vibrational decoupling promises an outstanding mechanical stability, demonstrated by the first generation of this instrument. Additionally, high frequency cables were implemented in the design in order to enable electron spin resonance experiments.

References: [1] T. Esat, P. Borgens, X. Yang, P. Coenen, V. Cherepanov, A. Raccanelli, F. S. Tautz, and R. Temirov, Review of Scientific Instruments 92, 063701 (2021).

O 21.3 Mon 18:00 P2/EG

atomic friction on TaS2 over a phase transition — •Yiming Song[1], Dirk Dietzel[1,2], and Andre Schirmeisen[1,2] — [1]Institute of Applied Physics (IAP), Justus-Liebig-Universität Gießen, 35392 Gießen, Germany — [2]Center for Materials Research, Justus-Liebig-Universität Gießen, 35392 Gießen, Germany

Friction force microscopy experiments were performed on tantalum disulfide (TaS2) surfaces as a function of temperature over the phase transition from nearly commensurate charge density wave (NCDW) phase to commensurate CDW phase. A giant frictional peak at the temperature of 187 K which separates CCDW and NCCDW phases when the sample is cooled down is observed. This behavior was investigated in detail by comparing atomic stick-slip motion of the single asperity AFM tip over phase transition. The hysteresis of the first order structural transformation is revealed in stick-slip behaviors during the heating up procedure as well. Besides, the load and velocity dependence of friction on TaS2 surface in CCDW and NCCDW phases have been revealed.

O 21.4 Mon 18:00 P2/EG

Design of a compact dilution refrigerator integrated in a dry mK UHV STM — •Michael Temmen, Simon Gerber, Michael Meyer, and Wulf Wulfhekel — Physikalisches Institut, Karlsruher Institut für Technologie, Karlsruhe, Deutschland

As energy and helium prices are rising we decided to design a new dry, low temperature Scanning Tunneling Microscope with a compact, low ^{3}He volume dilution refrigerator as the main innovation. Special focus was set on the heat exchanger between the still and the mixing chamber as one of the most crucial parts of the system. Next to the standard solution of a tube-in-tube heat exchanger, a new concept of a heat exchanger consisting of two laser cut metal sheets with deep drawn profiles acting as the channels for the Helium and a plain sheet in the middle as a divider is developed. In order to improve heat transfer while keeping the volume minimal, the surface area is increased by electrodeposition of three dimensional porous silver foam. Comparing this concept with the standard solution, an increase in surface area by a factor of 10 could be achieved with a reduction in ^{3}He volume in the exchanger by a factor of 10. The dilution refrigerator is integrated in a small scale cryostat with a closed helium cycle cooled by a pulse tube with a cooling capacity of 400 mW. The complete dilution refrigerator, cryostat and the STM are home-built.

O 21.5 Mon 18:00 P2/EG

Electromagnetic Field Mapping in Plasmonic Nanostructures using Momentum-Resolved Electron Energy-loss Spectroscopy — •Johannes Schultz[1], Jonas Krehl[1], Giulio Guzzinati[2], and Axel Lubk[1,3] — [1]Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden e. V., Helmholtzstraße 20, 01069 Dresden — [2]EMAT, University of Antwerp, Groenenborgerlaan 171, 2020 Antwerp — [3]Institute of Solid State and Materials Physics, Haeckelstraße 3, 01069 Dresden

Localized surface plasmons (LSPs) are collective oscillations of charge carriers arising at interfaces between media of opposite sign of the dielectric functions. Here, spatial confinement of the LSPs, e.g. in nanoparticles (NPs), may lead to enhanced electromagnetic (e.m.) fields of the LSPs due to resonance. This effect is exploited in several application, e.g., surface enhanced Raman spectroscopy. To characterize the e.m. fields scanning transmission electron microscopy in combination with electron energy loss spectroscopy is a frequently used technique due to its high spectral and spatial resolution. Here, the energy loss of the beam electrons (caused by the electric field component of the LSPs parallel to the beam) is measured at different probe positions. This technique has been generalized to additionally probe in-plane field components by measuring the deflection of the beam electrons from their initial trajectory. To that end spectrally resolved deflection maps (so-called $\omega - q$ maps) are recorded at different probe positions which opens up new capabilities to e.g., probe magnetic field contributions of the LSPs at highest spectral and spatial resolution.

O 21.6 Mon 18:00 P2/EG

SpmImage Tycoon: Organize scanning probe microscopy data — •Alexander Riss — Physics Department E20, Technical University of Munich, D-85748 Garching. Germany

The evolution of the field of scanning probe microscopy (SPM) has been associated with development of instrumental capabilities and methods for data acquisition and analysis. However, much less emphasis has been placed on improving the management and organization of the measured datasets. And while datasets can consist of thousands of images and spectra per project, it is not uncommon for researchers to go through each image or spectrum and manually select the channels of interest for each one — only to repeat the same procedure every time they want to analyze their data again.

Here we present a cross-platform application that is designed for fast and effortless organization and basic editing of scanning probe microscopy images and spectra [1]. The application is released under an open-source license and supports automatic channel-of-interest detection, image editing (such as background corrections and contrast adjustment), keywording, star-ratings, powerful search and filtering (e.g., by keywords, data type, location, scan size), as well as export of the data into a PowerPoint-compatible presentation format.

Such easy-to-use tools can lower the entry barrier for aspiring scientists, boost the efficiency of experienced researchers, and help to create and leverage large SPM datasets for machine learning and artificial intelligence applications.

[1] A. Riss. JOSS 7, 4644 (2022)

O 21.7 Mon 18:00 P2/EG

Electric field control of spin transitions in a dimer system

using ESR-STM — •Maneesha Ismail[1], Piotr Kot[2], Janis Siebrecht[1], Haonan Huang[1], and Christan R. Ast[1] — [1]Max-Planck-Institute for Solid State Research, Heisenbergstr. 1, 70569 Stuttgart, Germany — [2]Center for Quantum Nanoscience, Institute for Basic Science, Seoul 03760, Republic of Korea

Since the demonstration of the control of spins on the atomic scale, the technique of ESR-STM has been used extensively to explore the field of spintronics. Here, we present a new approach to ESR-STM which uses the bias voltage as a parameter to tune the energy of the Zeeman transition. We demonstrate electronic control of spin resonance transitions in a single molecule. We could observe a strong dependency of the g-factor and tip-field shift on the electric field. Finally, we demonstrate an avoided crossing in the energy levels of a dimer as a function of bias voltage, which corresponds to an entangled state. This could be an important step towards quantum computations as they rely on entanglement opening a more coherent and easier method of electronic spin control.