MA 27: Complex Oxides: Surfaces and Interfaces (jointly with DS, HL, KFM, MA, O) (joint session TT/MA/HL)

Time: Tuesday 14:00–15:45 Location: HSZ 02

MA 27.1 Tue 14:00 HSZ 02

Ultradense tailored vortex pinning arrays in $YBa_2Cu_3O_{7-\delta}$ thin films created by He ion beam irradiation — •Max Karrer[1], Bernd Aichner[2], Benedikt Müller[1], Vyacheslav Misko[3], Kristijan L. Mletschnig[2], Meirzhan Dosmailov[4], Johannes D. Pedarnig[4], Franco Nori[3], Reinhold Kleiner[1], Wolfgang Lang[2], and Dieter Koelle[1] — [1]Physikalisches Institut and Center for Quantum Science (CQ) in LISA$^+$, Universität Tübingen, Germany — [2]Faculty of Physics, University of Vienna, Austria — [3]Theoretical Quantum Physics Group, RIKEN Cluster for Pioneering Research, Wako-shi, Saitama, Japan — [4]Institute of Applied Physics, Johannes Kepler University Linz, Austria

Magnetic fields penetrate a type II superconductor as magnetic vortices. In a clean superconductor they arrange in a hexagonal lattice; by addition of artificial pinning sites many other arrangements are possible. With a focused He ion beam, we fabricate periodic patterns of pinning sites with spacings down to 70 nm in $YBa_2Cu_3O_{7-\delta}$ thin films. In ultradense kagomé-like patterns, magnetic caging of vortices results in unconventional commensurability effects, yielding peaks in the critical current and minima in the resistance versus applied field up to ~ 0.4 T. The various vortex patterns at different magnetic fields are analyzed by molecular dynamics simulations of vortex motion, and the magnetic field dependence of the critical current is confirmed. These findings open the way for a controlled manipulation of vortices in cuprate superconductors by artificial sub-100 nm pinning landscapes.

[1] B. Aichner *et al.*, ACS Appl. Nano Mater. **2**, 5108–5115 (2019).

MA 27.2 Tue 14:15 HSZ 02

Strain-dependent electronic reconstruction in Sr_2CoIrO_6 double perovskite from DFT+U+SOC calculations — •Jiongyao Wu and Rossitza Pentcheva — Department of Physics and Center for Nanointegration (CENIDE) Universitat Duisburg-Essen, Duisburg, Germany

The double perovskite Sr_2CoIrO_6 (SCIO) can be regarded as a (111)-superlattice of alternating $SrIrO_3$ (SIO) and $SrCoO_3$ (SCO) layers. Here we explore the electronic and magnetic properties in the framework of density functional theory (DFT) including a Hubbard U term and spin-orbit coupling (SOC) with the PBEsol exchange correlation functional. While the end member SIO is metallic with a quenched spin and orbital moment and bulk SCO is a G-type antiferromagnetic (AFM) insulator with spin and orbtial moment of 2.7 and 0.26 μ_B, respectively, the double perovskite SCIO emerges as an AFM Mott insulator with a band gap of $\sim$ 500 - 600 meV. Additionally, Ir acquires a spin moment of 1.5 μ_B pointing towards a $j = 1/2$ Mott insulating state in SCIO, similar to other iridates. Analysis of the orbital occupation indicates substantial charge transfer from the Ir to the Co ion. Moreover, subtle changes in orbital occupation are observed as the strain is varied from compressive (a_{NdGaO_3}) to tensile (a_{SrTiO_3}).

We acknowledge funding by the German Science Foundation within CRC/TRR80, project G3.

MA 27.3 Tue 14:30 HSZ 02

Sensitivity of non-local fluctuations on surface effects in ultrathin $SrVO_3$ films — •Matthias Pickem, Jan M. Tomczak, and Karsten Held — Institute of Solid State Physics, TU Wien, Austria

Recent experiments show that strong electronic correlations cause the conventional Fermi-liquid state of bulk $SrVO_3$ to be destroyed in films below a critical thickness. However new experimental results challenge the current understanding of the details of this breakdown.

To this end we perform realistic density functional theory (DFT) + dynamical mean-field theory (DMFT) calculations of $SrVO_3$ on $SrTiO_3$ substrate. Depending on the simulated interface ($SrVO_3$ termination, surface reconstructions, or additional $SrTiO_3$ capping) we find that different mechanism cause this aforementioned break-down of the Fermi-liquid state.

Furthermore, calculations on the two-particle level (DMFT susceptibilities) reveal that the different interfaces result in vastly different instabilities.

MA 27.4 Tue 14:45 HSZ 02

Planar GHz resonators on $SrTiO_3$: Suppressed losses at temperatures below 1 K — Vincent T. Engl, Nikolaj G. Ebensperger, Lars Wendel, and •Marc Scheffler — 1. Physikalisches Institut, Universität Stuttgart, 70569 Stuttgart, Germany

The complex dielectric constant $\hat{\epsilon} = \epsilon_1 + i\epsilon_2$ of $SrTiO_3$ reaches high values $\epsilon_1 \approx 2 * 10^4$ at cryogenic temperatures, while the dielectric losses (ϵ_2) are much stronger than for other crystalline dielectrics. $SrTiO_3$ is a common substrate for oxide thin films, like the superconducting $LaAlO_3/SrTiO_3$ system, but the large ϵ_1 and ϵ_2 restrict high-frequency quantum devices on $SrTiO_3$. Here we present superconducting coplanar Nb resonators on $SrTiO_3$, which we successfully operate in a distant-flip-chip geometry [1] at frequencies that exceed 1 GHz. We find a pronounced and unexpected increase in resonator quality factor Q at temperatures below 1 K, reaching up to $Q \approx 800$. We attribute this to substantial changes of the dielectric losses in $SrTiO_3$ at mK temperatures, and we also detect non-monotonous changes in the temperature-dependent ϵ_1. These findings [2] challenge our present understanding of the dielectric properties of $SrTiO_3$ and at the same time demonstrate that cryogenic high-frequency devices on $SrTiO_3$ are more feasible than previously assumed.

[1] L. Wendel *et al.* arXiv:1911.10518 [cond-mat.supr-con]
[2] V. T. Engl *et al.* arXiv:1911.11456 [cond-mat.supr-con]

MA 27.5 Tue 15:00 HSZ 02

Tuning superconductivity at the $Al_2O_3/SrTiO_3$-interface with light — •Daniel Arnold, Dirk Fuchs, and Roland Schäfer — Institute for Solid State Physics, Karlsruhe Institute of Technology, Karlsruhe, Germany

The 2-DEG at $SrTiO_3$-based interfaces is sensitive to illumination with visible light [1], which at low temperatures can be used to tune the transition temperature of the superconducting state in a nonvolatile manner [2]. We present studies on an $Al_2O_3/SrTiO_3$ sample with micro bridges running along different crystallographic directions at the interface. We are able to tune the low temperature conductance by illuminating the sample and reverse the altered state by thermal treatment at low temperatures ($T < 15$ K). Transport measurements in dependence of the magnetic field and temperature are conducted in different states, characterized by the tunable but time independent resistance at 1 K. The Berezinskii-Kosterlitz-Thouless transition in this system can be addressed by the current voltage behavior, which simultaneously gives further information on the inhomogeneous nature of the superconducting phase.

[1] M. Yazdi-Rizi et al., PRB 95 (2017)
[2] D. Arnold et al., APL 115 (2019)

MA 27.6 Tue 15:15 HSZ 02

Crystalline anisotropy of magnetoresistance in LAO/STO nanostructures — •Mithun Sheena Prasad[1] and Georg Schmidt[1,2] — [1].Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, Von-Danckelmann-Platz 3, D-06120 Halle, Germany — [2]Interdisziplinäres Zentrum für Meterialwissenschaften, Martin-Luther-Universität Halle-Wittenberg, Heinrich-Damerow-Straße 4, D-06120 Halle, Germany

The high-mobility two-dimensional electron gas (2DEG) confined at the interface $LaAlO_3$ (LAO) and $SrTiO_3$ (STO) provides new opportunities to explore Nano electronic devices. In our group we have developed an industry compatible Nano patterning technique [1] for the LAO/STO interface. Recent studies on this interface have revealed that at low temperature the current is confined to filaments which are linked to structural domain walls in the STO with drastic consequences for example for the temperature dependence of local transport properties. We have investigated magneto-transport in nanostructures having different orientation with respect to the lattice. Our experiments show that not only the resistance but also the magnetoresistance varies with orientation. The magnetoresistance can even change sign for different orientations and again this can change after a warm-up cool-down cycle strongly supporting the model of filamentary charge transport.

[1] M. Z. Minhas, H. H. Blaschek, F. Heyroth, and G. Schmidt, AIP Advances 6, 035002 (2016)

MA 27.7 Tue 15:30 HSZ 02

Study of 2D superconductivity at oxide interfaces by microwave resonators — •Edouard Lesne[1], Yildiz Saglam[1], Daniel Bothner[1], Felix Schmidt[1], Marc Gabay[2], Gary Steele[1], and Andrea Caviglia[1] — [1]Delft University of Technology — [2]Université Paris-Saclay

The emergent two-dimensional electron system (2DES) formed at the interface between LaAlO3 (LAO) and SrTiO3 (STO) insulating oxides has been a subject of great interest in condensed matter physics during the last decade. Recently, (111)-oriented LAO/STO interfaces have been shown to exhibit an electronic correlation driven reconstruction of its band structure and a two-dimensional superconducting (SC) ground state, both tunable by electrostatic field-effect.

Superconducting coplanar waveguide (SCPW) resonators are tools of exquisite sensitivity for probing low energy excitations in quantum materials, due to their intrinsic low ohmic losses and high quality factors, highly relevant to quantum technology platforms. Here, in order to study the superconducting state at the LAO/STO(111) interface, we designed embedded SCPW resonators whose microwave resonance frequency can be tuned by electrostatic gating, manifesting a change of the 2DES superfluid density through a large change of its kinetic inductance. This allows us to map the SC phase diagram in a detection scheme that goes beyond traditional resistive measurements. Our work highlights the potential of such an approach to the fundamental study of superconductivity in complex materials.