TT 54: Superconductivity: Heterostructures

Time: Wednesday 9:45–11:00 Location: H 3005

TT 54.1 Wed 9:45 H 3005

Quenching long range magnetic excitations in oxygen sublattice reconstructed thin films of $(SrCuO_2)_n/(SrTiO_2)_2$ superlattices — •Marcus Dantz[1], Jonathan Pelliciari[1], Yaobo Huang[1], Debakanta Samal[2], Valentina Bisogni[1], Paul Olalde-Velasco[1], Vladimir Strocov[1], Gertjan Koster[2], and Thorsten Schmitt[1] — [1]Paul Scherrer Institut, CH-5232 Villigen PSI, Switzerland — [2]MESA+ Institute for Nanotechnology, University of Twente

Multi-layered thin cuprate films allow inducing subtle structural changes with which local crystal field and long range magnetic excitations can be finely tuned [1,2]. In $(SrCuO_2)_n/(SrTiO_2)_2$ cuprate superlattices, in particular, a structural transformation from a bulk infinite planar to a sheet-like local domain environment has recently been predicted and subsequently observed [3,4]. Here we present results on the influence of this subtle structural reconstruction on the collective magnetic excitations using high-resolution resonant inelastic x-ray scattering (RIXS) at the Cu L_3 edge. While bulk like infinite layer films exhibit magnon excitations throughout the whole Brillouin zone, decreasing the thickness of the cuprate layers leads to quenching of the magnons starting from the Gamma point successively to the zone boundary, allowing us to study the coherence length of the collective long range magnetic excitations in these cuprate superlattices.

[1] Minola et al. PRB 85 235138 (2012).
[2] Dean et al. Nat. Mater. 11, 850 (2012).
[3] Zhong et al. PRB 85, 121411 (2012).
[4] Samal et al. PRL 111 096102 (2013).

TT 54.2 Wed 10:00 H 3005

On the universality of the "smile"-gap in the Density of States of a chaotic Josephson junction — •Johannes Reutlinger[1], Yuli Nazarov[2], Leonid Glazman[3], and Wolfgang Belzig[1] — [1]University of Konstanz, Department of Physics, 78457 Konstanz, Germany — [2]Kavli Institute of Nanoscience Delft, Delft University of Technology, 2628 CJ Delft, Netherlands — [3]Department of Physics, Yale University, New Haven CT 06511-8499, USA

The superconducting proximity effect strongly modifies the local density of states in chaotic Josephson junctions. Recently we found that besides the well-known minigap a secondary gap appears just below the superconducting gap edge Δ in the limit of a large Thouless energy $E_{\rm Th} \gtrsim \Delta$ [1]. To check the universality of this novel gap phenomenon we study the effect of nonideal contacts and show that the "smile"-gap crucially depends on the transmission eigenvalue distribution [2]. In a next step we use the random matrix method to investigate the "smile"-gap. This allows us to approach the statistics of Andreev levels, going beyond the quasiclassical Greens function method. It turns out that the hard gap edge softens similar to what is already known from the minigap.

[1] J. Reutlinger, L. Glazman, Yu. V. Nazarov, W. Belzig, Phys. Rev. Lett. **112**, 067001 (2014)
[2] J. Reutlinger, L. Glazman, Yu. V. Nazarov, W. Belzig, Phys. Rev. B **90**, 014521 (2014)

TT 54.3 Wed 10:15 H 3005

Thermodynamics of superconducting quantum metamaterials — •Pierre-Luc Dallaire-Demers and Frank Wilhelm-Mauch — Universität des Saarlandes

Left-handed matematerials are capacitively coupled layers of inductive pieces of conductors. These systems are well studied in the context of microwave metamaterials but their full quantum description or their embedding in highly correlated materials like superconductors are still an open problem. Notably, they are known to have a Van Hove singularity in the density of states at low energy and high pseudo-momentum that could effectively couple and condense Cooper pairs. The goal of this research is to analyze the thermodynamical properties of the order parameter of stacked layers of superconductors with a small repulsive Coulomb interaction. A 3D toy model of such a material is mapped to a Fermi-Hubbard lattice. The temperature dependent anomalous correlation functions are computed variationally from a self-energy functional of a small cluster where inter-cluster tunneling is treated perturbatively. The effect of the repulsive interaction on the Cooper pairs binding can then be seen from the momentum distribution of the condensation amplitude. Such a material could potentially be realized with optical lattices or nanoscaled superconductors.

TT 54.4 Wed 10:30 H 3005

Triplet correlations at ferromagnet/superconductor interfaces: Mechanism and implications — •Daniel Fritsch and James F. Annett — H. H. Wills Physics Laboratory, University of Bristol, Tyndall Avenue, Bristol BS8 1TL, United Kingdom

The interface between a ferromagnet and an s-wave superconductor offers a rich variety of physical phenomenons due to different intrinsic correlation effects. Even more interesting phenomenons are to be expected if the interface region allows for some kind of spin-flip mechanism, thus generating equal-spin spin-triplet correlations which are compatible with the ferromagnetic exchange field and leading to the observable long-range proximity effect.

Here, we present results based on numerical solutions of the spin-generalised microscopic Bogoliubov−de Gennes equations incorporating a tight-binding model in the clean limit [1-3]. We compare different types of interfaces that have been suggested to generate spin-triplet pairing correlations and discuss implications on the effectiveness.

[1] D. Fritsch and J. F. Annett, New J. Phys. **16**, 055005 (2014).
[2] D. Fritsch and J. F. Annett,
J. Phys.: Condens. Matter **26**, 274212 (2014).
[3] D. Fritsch and J. F. Annett,
Phil. Mag., accepted and published online (2014).

TT 54.5 Wed 10:45 H 3005

Superconducting Spin Valve Effect in Fe/In based heterostructures — •Pavel Leksin[1], Nadir Garifyanov[2], Ilgiz Garifullin[2], Joachim Schumann[1], Vladislav Kataev[1], Oliver Schmidt[1], and Bernd Büchner[1] — [1]Leibniz Institute for Solid State and Materials Research IFW Dresden, DE-01171 Dresden, Germany — [2]Zavoisky Physical-Technical Institute, Kazan Scientific Center of Russian Academy of Sciences, 420029 Kazan, Russia

We report on magnetic and superconducting properties of the spin-valve multilayer system CoOx/Fe1/Cu/Fe2/In. The Superconducting Spin Valve Effect (SSVE) assumes the T_c difference between parallel (P) and antiparallel (AP) orientations of the Fe1 and Fe2 layers' magnetizations. The SSVE value oscillates and changes its sign when the Fe2 layer thickness d_{Fe2} is varied from 0 to 5 nm. The SSVE value is positive, as expected, in the range 0.4 nm $\leq d_{Fe2} \leq$ 0.8 nm. For a rather broad range of thicknesses 1 nm $\leq d_{Fe2} \leq$ 2.6 nm the SSVE has negative sign assuming the inverse SSVE. Moreover, the magnitude of the inverse effect is larger than that of the positive direct effect. We attribute these oscillations to a quantum interference of the cooper pair wave functions in the magnetic part of the system. For most of the spin-valve samples from this set we experimentally realized the full switching between normal and superconducting states due to direct and inverse SSVE. The analysis of the experimental data has enabled the determination of all microscopic parameters of the studied system [1].

[1] P. V. Leksin et al., Phys. Rev. B 85, 024502 (2012).