TT 16: Superconductivity: Properties and Electronic Structure II

Time: Monday 15:00–17:30 Location: H 0110

TT 16.1 Mon 15:00 H 0110

Resistivity in the Vicinity of a Van Hove Singularity: Sr_2RuO_4 Under Uniaxial Pressure — •Mark E. Barber[1,2], Alexandra S. Gibbs[2,3], Yoshiteru Maeno[4], Andrew P. Mackenzie[1,2], and Clifford W. Hicks[1] — [1]Max Planck Institute for Chemical Physics of Solids, Dresden, Germany — [2]Scottish Universities Physics Alliance (SUPA), University of St. Andrews, United Kingdom — [3]ISIS Facility, Rutherford Appleton Laboratory, United Kingdom — [4]Department of Physics, Kyoto University, Japan

Sr_2RuO_4 is an unconventional superconductor with a well characterised Fermi liquid normal state. One of its three conduction bands is known to be in close proximity to a Van Hove singularity. We have previously shown that the application of uniaxial pressure causes T_c to pass through a strong peak at a uniaxial compression of 0.6 %, and at which T_c is more than double its value in the unstrained lattice. DFT calculations provide strong evidence that this peak coincides with tuning the Van Hove singularity to the Fermi level. Here, we present data on the normal-state resistivity as Sr_2RuO_4 is tuned through this peak and analyse the temperature dependence, which also appears to be consistent with a Van Hove singularity. In particular, the low-temperature resistivity also passes through a pronounced peak - arguably a surprise because the singularity affects only small sections of one Fermi surface - and at the peak its temperature dependence deviates strongly from the Fermi liquid T^2 dependence.

TT 16.2 Mon 15:15 H 0110

Muon spin relaxation studies of Sr_2RuO_4 under uniaxial pressure — •Shreenanda Ghosh[1], Rajib Sarkar[1], Vadim Grinenko[1], Jean-Christophe Orain[2], Hubertus Luetkens[2], Joonbum Park[3], Clifford Hicks[3], and Hans-Henning Klauss[1] — [1]Institute of Solid State and Materials Physics, TU Dresden, D-01069 Dresden, Germany — [2]Laboratory for Muon-Spin Spectroscopy, Paul Scherrer Institute, CH-5232 Villigen, Switzerland — [3]Max-Planck Institute for Chemical Physics of Solids, 01187 Dresden, Germany

We present transverse field muon spin relaxation data on the unconventional superconductor Sr_2RuO_4 under uni axial pressure. Results from previous μSR studies on unstressed Sr_2RuO_4 indicate a spontaneous magnetization in the superconducting state [1], that has been associated with a time reversal symmetry breaking order parameter, $p_x \pm ip_y$. The superconducting T_c of Sr_2RuO_4 has been shown experimentally to be sensitive to uni axial pressure [2], so for more information about the complex superconducting order parameter, we investigate pressurized Sr_2RuO_4 by μSR. For this purpose, we have developed a dedicated device, which offers in situ uni axial strain tuning via piezoelectric stacks.[5]

[1] G.M.Luke et al., Nature, 394, 558 (1998).
[2] J.R.Kirtley et al., Phys.Rev.B, 76, 014526 (2007).
[3] C.W.Hicks et al., Science, 344, 283 (2014)
[4] Steppke et al. Science 355,6321(2017)
[5] C.Hicks et al.accepted in Conference proceedings of μSR 2017

TT 16.3 Mon 15:30 H 0110

Heat Capacity Measurements of Sr_2RuO_4 Under Uniaxial Stress — •You-Sheng Li[1,2], Alexandra Gibbs[3], Naoki Kikugawa[5], Dmitry Sokolov[1], Yoshiteru Maeno[4], Andrew P. Mackenzie[1,2], Clifford W. Hicks[1], and Michael Nicklas[1] — [1]Max Planck Institute for Chemical Physics of Solids, Dresden, Germany — [2]University of St. Andrews, School of Physics and Astronomy, United Kingdom — [3]Max Planck Institute for Solid State Research, Stuttgart, Germany — [4]Department of Physics, Graduate School of Science, Kyoto University, Kyoto, Japan — [5]Research Center for Functional Materials, National Institute for Materials Science, Tsukuba, Ibaraki 305-0003, Japan

We present heat capacity measurements on the superconductor Sr_2RuO_4 under uniaxial stress. Under uniaxial stress, the degeneracy of the components p_x and p_y of the proposed superconducting order parameter $p_x \pm ip_y$ should be lifted, resulting in two heat capacity jumps. We have now measured four samples of varying quality, including one where, thanks to high sample quality and careful mounting, the transitions remain very sharp as strain is applied. In measurements up to the peak in Tc (at 3.6 K and a compression of 0.6%), no splitting is observed at any strain. We discuss whether this null result can still be consistent with a hypothesis of $p_x \pm ip_y$ superconductivity.

TT 16.4 Mon 15:45 H 0110

Mixed-pairing superconductivity in 5d Mott insulators with antisymmetric exchange — Mohammad-Hossein Zare[1], Mehdi Biderang[2], and •Alireza Akbari[2] — [1]Department of Physics, Qom University of Technology, Qom, Iran — [2]Asia Pacific Center for Theoretical Physics, POSTECH, Pohang, Korea

Currently, remarkable attentions have been attracted to exotic physics driven by the interplay of the spin-orbit coupling and electronic correlations. Particularly, in 5d transition metals, neither the spin-orbit coupling nor the Coulomb interaction can merely lead to the insulating behavior. We study the symmetry of the potential superconducting order parameter in 5d Mott insulators with an eye to hole doped Sr_2IrO_4. Using a mean-field method, a mixed singlet-triplet superconductivity, $d + p$, is observed due to the antisymmetric exchange originating from a quasi-spin-orbit-coupling. Our calculation of ribbon geometry shows possible existence of the topologically protected edge states, because of nodal structure of the superconducting gap. These edge modes are spin polarized and emerge as zero-energy flat bands, supporting symmetry protected Majorana state, verified by evaluation of winding number and $\mathbb{Z}_2$ topological invariant. At the end, a possible experimental approach for observation of these edge states and determination of the superconducting gap symmetry are discussed based on the quasi-particle interference (QPI) technique.

[1] Phys. Rev. B 96, 205156 (2017)

TT 16.5 Mon 16:00 H 0110

Vortex dynamics in driven Type-II Superconductor heterostructures — •Björn Niedzielski and Jamal Berakdar — Martin-Luther Universität Halle-Wittenberg, Halle, Germany

Superconductors exhibit a variety of intriguing phenomena in the presence of magnetic fields. For example, type-II Superconductors respond to an external field by generating vortices of magnetic flux. Our aim is to control the motion of these flux lines as well as to understand their nature in confined geometries and in the proximity of ferromagnetic or multiferroic order. Along this direction we will present simulations obtained from solving the time-dependent Ginzburg-Landau-Equations and discuss the behavior of the simulated systems. The role of material parameters, external magnetic fields and currents will be discussed. We will also show how the shape of the sample influences the dynamics of the superconducting order parameter.

15 min. break.

TT 16.6 Mon 16:30 H 0110

Experimental test of an alternative electrodynamic theory of superconductors by means of scanning tunnelling and force microscopy — Sungmin Kim[1,4], Johannes Schwenk[1,2], Julian Berwanger[3], •Angelo Peronio[3], Steven R. Blankenship[1], William G. Cullen[1], Young Kuk[4], Franz J. Giessibl[3], and Joseph A. Stroscio[1] — [1]NIST, Gaithersburg, Maryland — [2]University of Maryland, College Park, Maryland — [3]University of Regensburg, Germany — [4]Seoul National University, Korea

In the traditional theoretical description of superconductivity, a static electric field cannot penetrate a superconductor, since screening occurs like in a normal metal. This can be traced back to the fact that the London equations [1], the phenomenological equations describing the electrodynamics of superconductors, are derived within the Coulomb gauge. J. E. Hirsch proposes to use the Lorenz gauge instead [2], deriving a consistent solution where the electric field penetrates the superconductor up to the London penetration depth.

If a superconductor screens electric fields differently from a normal metal, the electrostatic interaction between a scanning probe tip and a superconductive sample should change when the latter becomes superconductive. We report on experiments to test Hirsch's hypothesis, performed on aluminium samples in a combined STM/AFM microscope operated in ultra-high vacuum at mK temperatures.

[1] F. London, Superfluids Vol. I, Wiley (1950)
[2] J. E. Hirsch, Physica C 508, 21 (2015)

TT 16.7 Mon 16:45 H 0110

Fabrication of electrospun BSCCO nanowire networks with reduced preparation temperature — •Michael Koblischka[1], XianLin Zeng[1], Fabian Laurent[1], Thomas Karwoth[1], Angela Koblischka-Veneva[1], Uwe Hartmann[1], Crosby Chang[2], Thomas Hauet[2], Praveen Kumar[3], and Oliver Eibl[3] — [1]Institute of Experimental Physics, Saarland University, Campus C 6 3, D-66123 Saarbrücken, Germany — [2]Institut Jean Lamour, UMR CNRS-Université de Lorraine, 54506 Vandoevre-lès-Nancy, France — [3]Institute of Applied Physics, University of Tübingen, 72076 Tübingen, Germany

$Bi_2Sr_2CaCu_2O_{8+\delta}$ (Bi-2212) nanowire networks [1] were fabricated by electrospinning. A thermal treatment is required to obtain the final crystal structure, however, if the preparation temperature is too high, the nanowire structure may completely collapse. Therefore, Li acetate was added in various amounts to the starting composition. This enabled us to produce the desired Bi-2212 phase already at 750 °C instead of 840 °C. X-ray and TEM analysis proved that the resulting nanowires were single-phase Bi-2212. After electrospinning, the resulting samples form fabric-like networks, and the nanowire structure survived. The nanowires exhibit a polycrystalline structure with grain sizes of 20-50 nm, an average wire diameter of 100 nm and a length of up to several micrometers. The nanowire network samples were characterized by magnetic and electric measurements in fields up to 7 T. This work is part of DFG-project Ko2323/8.

[1] M.R.Koblischka et al., AIP Adv. 6, 035115 (2016).

TT 16.8 Mon 17:00 H 0110

Electrospun BSCCO donut-shaped superconducting rings — •XianLin Zeng, Fabian Laurent, Michael Koblischka, and Uwe Hartmann — Institute of Experimental Physics, Saarland University, Campus C 6 3, D-66123 Saarbrücken, Germany

By means of electrospinning, $Bi_2Sr_2CaCu_2O_{8+\delta}$ (Bi-2212) nanowire networks were fabricated. Using the as-spun polymer nanowires, we were able to create donut-shaped superconducting rings via mechanical treatment. These samples were heat-treated at 840 °C to form the superconducting phase and to remove the polymer. On the donut-shaped nanowire samples, we performed magnetization measurements in a PPMS magnetometer in fields up to 7 T to investigate their behavior concerning trapping of magnetic fields and persistent currents flowing in the remanent state after application of magnetic fields. Using a Hall probe, we measured the local field, Bi, inside the rings at various temperatures and fields. Our results show that these donut-shaped rings can act as magnetic shields at low temperatures.

This work is part of DFG-project Ko2323/8.

TT 16.9 Mon 17:15 H 0110

Experimental evidences of a possible superconducting transition above room temperature in natural graphite crystals — •Christian Eike Precker[1], Pablo David Esquinazi[1], Markus Stiller[1], José Luis Barzola Quiquia[1], and Ana Melva Champi Farfan[2] — [1]Felix-Bloch-Institut, Universität Leipzig, Linnéstr. 5, 04103 Leipzig, Germany. — [2]CCNH, Universidade Federal do ABC, São Paulo, Brazil

By use of the four-terminal sensing method and high resolution electrical transport measurement, natural graphite samples from Brazil and Sri Lanka mines were measured. Temperature dependent resistance *R(T)* measurements shows a step-like transition at $T \sim 350$ K. Further experiments were performed, like magnetization and time dependence *R(T)* after a field change, showing a magnetic irreversibility, i.e. trapped flux and flux creep and partial magnetic flux expulsion. All before mentioned experimental results suggest the existence of granular superconductivity below 350 K. X-rays diffraction measurements proved the existence of rhombohedral graphite phase in all measured samples, suggesting the presence of interfaces formed between the rhombohedral and Bernal phase as responsible for the high-temperature superconductivity, as predicted by theoretical calculations. The measured remanence in the magnetoresistance is due to pinned fluxons produced through superconducting currents. The current path of a graphite sample in remanence state has been measured using magnetic force microscopy. The current path vanished at the same critical temperature measured with the resistance.