TT 47: Superconductivity: Properties and Electronic Structure 2

Time: Wednesday 15:00–18:00 Location: HSZ 103

Invited Talk TT 47.1 Wed 15:00 HSZ 103

Interplay between CDW and Superconductivity: Effect of Pressure — •Matthieu Le Tacon — Karlsruher Institut für Technologie, Institut für Festkörperphysik, D-76021 Karlsruhe, Deutschland

I will focus on the interplay between superconductivity and charge density waves in superconducting cuprates and dichalcogenides. High resolution inelastic x-ray scattering was used to observe of a quasi-elastic *central peak* in underdoped $YBa_2Cu_3O_{6.6}$, demonstrating the static nature of the CDW correlations, attributed to the pining of CDW nanodomains on defects. Low energy phonons also exhibit anomalously large superconductivity induced renormalizations close to the CDW ordering wave vector, providing new insights regarding the long-standing debate of the role of the electron-phonon interaction, a major factor influencing the competition between collective instabilities in correlated-electron materials. Relationship to the well-known anomalies in reported in the higher energy phonon branches will be discussed. Finally, the dependence of these effects with pressure will be reported.

Pressure has also been used to tune the ground state of a less correlated material, 2H-$NbSe_2$. There a fast hardening of the soft phonon mode with pressure is observed, much faster than predicted by calculations carried out at the harmonic level. The inclusion of the full anharmonic potential in the calculation yields an excellent agreement with the experimental data and further allows demonstrating the major role of the electron-phonon interaction in the superconducting mechanism.

TT 47.2 Wed 15:30 HSZ 103

Thermodynamic and Raman study of untwinned $La_{1.8-x}Eu_{0.2}Sr_xCuO_4$ single crystals — •Julia Martius[1], Liran Wang[1], Peter Adelmann[1], Michael Merz[1], Frédéric Hardy[1], Mingquan He[1], Matteo Minola[2], Tomohioro Takayama[2], Hidenori Takagi[2], Christoph Meingast[1], and Matthieu Le Tacon[1] — [1]Institute for Solid-State Physics, Karlsruhe Institute of Technology, 76021 Karlsruhe, Germany. — [2]Max-Planck Institute for Solid State Research, Heisenbergstrasse 1, D-70569 Stuttgart Germany.

Partial substitution of La by Eu in $La_{2-x}Sr_xCuO_4$ leads to a stabilization of a low-temperature-tetragonal (LTT) phase, in which superconductivity is strongly suppressed at a doping of x = 1/8 [1]. This suppression has been attributed to long-range charge and magnetic ordering, which in $La_{1.8-x}Eu_{0.2}Sr_xCuO_4$ have been reported to occur at around 80 K and 30 K, respectively, i.e. well below the LTT transition at 130 K [2]. In this study we have looked for thermodynamic signatures of these ordering phenomena in high-quality untwinned single crystals using high-resolution thermal-expansion, specific-heat and magnetization measurements. The thermodynamic data are supplemented by electronic Raman measurements.

[1] B. Büchner *et al.*, Phys. Rev. Lett. 73, 1841 (1994).
[2] J. Fink *et al.*, Phys. Rev. B 83, 092053 (2011).

TT 47.3 Wed 15:45 HSZ 103

Changing the Start-point in the Cuprates — •Carsten Putzke — University of Bristol

Far over-doped $Tl_2Ba_2CuO_{6+\delta}$ is one of the cleanest and best understood members of the cuprate family. In this material quantum oscillation, specific heat and Hall effect measurements show good agreement with one another as well as band structure calculations. Choosing this as a start-point and reducing the oxygen stoichiometry enables to tune this system from far over-doped ($T_c < 4.2\,\mathrm{K}$) to optimal doping ($T_c = 94\,\mathrm{K}$) and even into the under-doped region. Thereby covering the entire over-doped part of the phase diagram. This proves particularly interesting as it allows us to study electronic correlation without the complication of the manifold ground states observed in the under-doped part of the phase diagram.

Starting from a Fermi-liquid like behaviour in far over-doped samples I will show results of the magnetoresistance and Hall effect in pulsed magnetic field that demonstrate the evolution of the electronic properties upon approaching the highest critical temperature in the system and the deviations from this evolution that accompany the entrance to the under doped regime.

TT 47.4 Wed 16:00 HSZ 103

Magnetic Flux Distribution in YBCO Thin Films Investigated via XMCD Microscopy at Low Temperatures — •Julian Simmendinger[1], Claudia Stahl[1], Stephen Ruoss[1], Markus Weigand[1], Gisela Schütz[1], and Joachim Albrecht[2] — [1]Max-Planck-Institute for Intelligent Systems, Heisenbergstraße 3, 70569 Stuttgart, Germany — [2]Research Institute for Innovative Surfaces, FINO, Aalen University, Beethovenstraße 1, 73430 Aalen

The magnetic flux distribution of high-T_c $YBa_2Cu_3O_{7-\delta}$ (YBCO) thin films exhibits structures within the submicrometer regime. Therefore scanning x-ray microscopy based on the x-ray magnetic circular dichroism effect (XMCD) is our method of choice revealing very high spatial resolution of both surface structure and magnetization distribution [1,2]. Introducing an XMCD sensitive, soft-magnetic CoFeB respectively Py sensor layer wherein the magnetic stray field of the superconductor is mapped [3], the critical current density and its dependency of the defect structure in the YBCO thin films are imaged and analyzed.

The measurements were carried out at the scanning x-ray microscope MAXYMUS at Bessy II, HZB Berlin utilizing a new low temperature setup.

[1] S. Ruoß et al., Appl. Phys. Lett. 106, 022601 (2015).
[2] S. Ruoß et al., New J. Phys. 18, 103044 (2016).
[3] C. Stahl et al., J. Appl. Phys. 117, 17D109 (2015).

TT 47.5 Wed 16:15 HSZ 103

Detailed analysis of magnetization loops of electrospun non-woven superconducting fabrics — •XianLin Zeng[1], Denis Gokhfeld[2], Thomas Karwoth[1], Michael Koblischka[1], Thomas Hauet[3], and Uwe Hartmann[1] — [1]Institute of Experimental Physics, Saarland University, Campus C 6 3, D-66123 Saarbrücken, Germany — [2]Kirensky Institute of Physics, Siberian Branch of the Russian Academy of Sciences, Akademgorodok 50/38, Krasnoyarsk, 660036 Russia — [3]Kirensky Institute of Physics, Siberian Branch of the Russian Academy of Sciences, Akademgorodok 50/38, Krasnoyarsk, 660036 Russia

Networks of superconducting $Bi_2Sr_2CaCu_2O_8$ (Bi-2212) nanowires were fabricated by the electrospinning technique. The nanowires form a non-woven, fabric-like network with numerous interconnects enabling a current flow between the nanowires. The porosity of this nanowire network is 0.9928. Therefore, this material represents a novel class of ultraporous high-temperature superconductors. The magnetization of the nanowire networks were recorded by SQUID magnetometry. The magnetic properties were analyzed using the extended critical state model (ECSM). Single nanowires have remarkably high values of the critical current density of 1.69×10^7 A/cm^2 at 5 K. The resulting sample critical current density of 7.44×10^4 A/cm^2 at 5 K is fine for this lightweight material. Using the ECSM, several important magnetic parameters could be determined including the penetration field, H_p, the irreversibility fields, H_{irr}, the upper critical field, H_{c2}, and the flux pinning forces.

15 min. break.

TT 47.6 Wed 16:45 HSZ 103

Heat Capacity Measurements of Sr_2RuO_4 Under Uniaxial Stress — •You-Sheng Li[1,2], Alexandra Gibbs[3], Andrew Mackenzie[1,2], Clifford 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

One of the most-discussed possible pairing symmetries of the superconductor Sr_2RuO_4 is $p_x \pm ip_y$. By applying in-plane uniaxial stress, the degeneracy of the p_x and p_y components should be lifted, yielding two critical temperatures (T_c). Hicks et al. observed an increase of T_c of Sr_2RuO_4 under both compressive and tensile stress [1], and did not find evidence for splitting of transition. However, that result was based on magnetic susceptibility measurements, which would be sensitive only to the upper transition. For a direct test of possible splitting, we measure the heat capacity of Sr_2RuO_4 under uniaxial stress. To do so, we have developed an approach to measure heat capacity under non-adiabatic conditions. We have observed the increase in T_c

under compressive strain, providing the first thermodynamic evidence for the strain-induced increase in T_c of Sr_2RuO_4, and also resolve strong strain-induced changes in the normal-state heat capacity.

[1] Clifford W. Hicks et al., Science 344, 283 (2014).

TT 47.7 Wed 17:00 HSZ 103

Upper Critical Field of Strained and Unstrained Sr_2RuO_4 — •Fabian Jerzembeck[1], Alexander Steppke[1,2], 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, Nöthnitzer Str. 40, 01187 Dresden, Germany — [2]Scottish Universities Physics Alliance (SUPA), School of Physics and Astronomy, University of St. Andrews, St. Andrews KY16 9SS, United Kingdom — [3]ISIS Facility, Rutherford Appleton Laboratory, Chilton, Didcot OX11 OQX, United Kingdom — [4]Department of Physics, Graduate School of Science, Kyoto University, Kyoto 606-8502, Japan

The dependence of the upper critical field H_{c2} of a superconductor on temperature can provide information on structure of the gap. We have recently shown that T_c of the unconventional superconductor Sr_2RuO_4 can be dramatically enhanced by uniaxial pressure, most likely due to tuning one of the Fermi surfaces through a Lifshitz transition. We have also shown that the form of $H_{c2}(T)$ is very different between unstressed and highly-stressed Sr_2RuO_4. In this talk, we present further data on H_{c2} of stressed and unstressed Sr_2RuO_4, and discuss how pressure is modifying the gap.

[1] A. Steppke et al. arXiv:1604.06669

TT 47.8 Wed 17:15 HSZ 103

Microwave spectroscopy on superconducting Nb:SrTiO$_3$ at mK temperatures — •Markus Thiemann[1], Manfred Beutel[1], Evangelos Fillis-Tsirakis[2], Hans Boschker[2], Jochen Mannhart[2], Martin Dressel[1], and Marc Scheffler[1] — [1]1. Physikalisches Institut, Universität Stuttgart — [2]Max Planck Institute for Solid State Research, Stuttgart

Niobium-doped $SrTiO_3$ (Nb:STO) is a superconductor, exhibiting the lowest charge carrier density among all superconductors. It shows a dome in the transition temperature as a function of doping concentration with a maximum $T_c \approx 0.4$ K. Early tunneling experiments as well as more recent quantum oscillation measurements suggested Nb:STO being a multiband superconductor. Since the low intrinsic energy scales of the system are within the GHz range, microwave spectroscopy is the adequate contactless technique to reveal the intrinsic electronic properties of this system.

We performed microwave measurements on Nb:STO across the superconducting dome, using superconducting stripline resonators. We were able to determine the complex optical conductivity covering a temperature and frequency range of 70-500 mK and 1-20 GHz. From the complex conductivity we determined the temperature dependence of the superfluid density and superconducting energy gap. Both, as well as the frequency dependence of the complex conductivity can be described well with a single band BCS-model contradicting the multiband hypothesis.

TT 47.9 Wed 17:30 HSZ 103

Paramagnetic Meissner effect in topological superconductor candidate $Sr_xBi_2Se_3$ — •zhiwei wang[1], ruixing zhang[2], alexey taskin[1], huaixin yang[2], jianqi li[2], and yoichi ando[1] — [1]II. Physikalisches Institut, Universität zu Köln, Zülpicher Str. 77, 50937 Köln, Germany — [2]Institute of Physics, Chinese Academy of Science, 100190, Beijing, P. R. China

Single crystals of superconducting $Sr_xBi_2Se_3$ with the actual Sr content up to $x = 0.14$ have been grown. The highest $T_c = 3.12$ K has been observerd in $x = 0.048$ sample in electrical transport measurment and it dereases with the increase of actual Sr content. The highest superconducting volume fraction is close to 100% determined from magnetic susceptibility measurement at 1.75 K. An unexpected paramagnetic Messner effect (PME) has been observed in all measured $Sr_xBi_2Se_3$ samples at lower magnetic fields. We attribute this PME to imhomogeneous microstructure of $Sr_xBi_2Se_3$, which was supported by transmission eletron microscope (TEM) analysis. In addition, resistive transitions under magnetic fields point to an unconventional temperature dependence of the upper critical field B_{c2}.

TT 47.10 Wed 17:45 HSZ 103

topological quantum phase transition and superconductivity induced by pressure in the bismuth tellurohalide BiTeI — •Yanpeng Qi[1], Wujun Shi[1,2], Pavel G. Naumov[1], Nitesh Kumar[1], Raman Sankar[3,4], Walter Schnelle[1], Chandra Shekhar[1], F. C. Chou[4], Claudia Felser[1], Binghai Yan[1,2,5], and Sergey A. Medvedev[1] — [1]Max Planck Institute for Chemical Physics of Solids, 01187 Dresden, Germany — [2]School of Physical Science and Technology, ShanghaiTech University, Shanghai 200031, China — [3]Institute of Physics, Academia Sinica, Taipei 10617, Taiwan. — [4]Center for Condensed Matter Sciences, National Taiwan University, Taipei 10617, Taiwan. — [5]Max Planck Institute for the Physics of Complex Systems, 01187 Dresden, Germany.

A pressure-induced topological quantum phase transition has been theoretically predicted for the semiconductor BiTeI with giant Rashba spin splitting. In this work, the evolution of the electrical transport properties in BiTeI and BiTeBr is investigated under high pressure. The pressure-dependent resistivity in a wide temperature range passes through a minimum at around 3 GPa, indicating the predicted transition in BiTeI. Superconductivity is observed in both BiTeI and BiTeBr while the resistivity at higher temperatures still exhibits semiconducting behavior. Theoretical calculations suggest that the superconductivity may develop from the multi-valley semiconductor phase. The superconducting transition temperature Tc increases with applied pressure and reaches a maximum value of 5.2 K at 23.5 GPa for BiTeI (4.8 K at 31.7 GPa for BiTeBr), followed by a slow decrease.