TT 12: Poster Session Superconductivity

Time: Monday 15:00–19:00 Location: Poster D

TT 12.1 Mon 15:00 Poster D

Detector development for a neutrino mass determination using the ^{163}Ho electron capture spectrum — •P. Ranitzsch, M. Wegner, S. Kempf, L. Gamer, J. Geist, D. Hengstler, M. Krantz, E. Pavlov, C. Pies, S. Schäfer, S. Uhl, T. Wolf, A. Fleischmann, C. Enss, and L. Gastaldo — Kirchhoff-Institute for Physics, Heidelberg University

The absolute scale of the neutrino mass eigenstates is one of the puzzles in modern particle physics and can be directly investigated using electroweak decays. In the context of the ECHO collaboration we are developing metallic magnetic calorimeters (MMCs) to be used with an internal ^{163}Ho source to measure its electron capture (EC) spectrum.

MMCs are calorimetric particle detectors with paramagnetic temperature sensor operated below 100 mK. The sensor converts the temperature rise of the detector, due to the absorption of an energetic particle, to a change of magnetization which is detected by a SQUID magnetometer. MMCs fulfill the requirements for cryogenic neutrino mass investigations, namely an energy resolution ΔE_{FWHM} below 2 eV and pulse formation times of $\tau < 1\,\mu$s, as recently obtained with microfabricated MMCs for soft X-ray detection.

We present the calorimetric measurement of the EC spectrum of ^{163}Ho obtained with our first detector prototype. We discuss the development of a 64 pixel array readout.

TT 12.2 Mon 15:00 Poster D

Metallic magnetic calorimeters for high resolution x-ray spectroscopy - Latest results from maXs-20 and maXs-200 — •Mathäus Krantz, Sönke Schäfer, Christian Pies, Daniel Hengstler, Simon Uhl, Sebastian Georgi, Sebastian Heuser, Thomas Wolf, Sebastian Kempf, Loredana Gastaldo, Andreas Fleischmann, and Christian Enss — Kirchhoff-Institut für Physik, Uni Heidelberg, INF 227, 69120 Heidelberg

We are developing metallic magnetic calorimeters (MMC) for high resolution x-ray spectroscopy on highly charged ions in the energy range up to 200keV. MMCs use a paramagnetic temperature sensor, read-out by a SQUID, to measure the energy deposited by single x-ray photons. The recently micro-fabricated and tested prototypes include two linear 8-pixel detector arrays, maXs-20 and maXs-200, optimized for energies up to 20 keV and 200 keV, respectively. We discuss the physics of MMCs, design considerations concerning thermal and electro-magnetic cross talk, and the micro-fabrication. maXs-200 with its 1mm^2 large and 200 μm thick absorbers made of electro-deposited gold has high stopping power for hard x-rays and achieves an energy resolution of 40-60 eV (FWHM). maXs-20 with its 250μm×250 μm large and 5 μm thick absorbers has a stopping power of 98% for 6 keV photons and presently achieves an experimental line width of 3,3 eV (FWHM), with a signal rise time of 90 ns and excellent linearity. We are presently operating maXs-20 at an electron-beam-ion-trap at the MPI-K Heidelberg and will report on first atomic physics measurements as well as the particular challenges to detector operation in the vicinity of the EBIT.

TT 12.3 Mon 15:00 Poster D

Development of a large-area detector for position and energy resolving detection of molecular fragments — •L. Gamer, A. Fleischmann, L. Gastaldo, A. Kampkötter, S. Kempf, C. Pies, P. Ranitzsch, S. Schäfer, T. Wolf, and C. Enss — Kirchhoff Institute for Physics, Heidelberg University.

To investigate reactions like the dissociative recombination in laboratory environment, the Max-Planck Institute for Nuclear Physics in Heidelberg is presently building a cryogenic storage ring to prepare molecular ions in their rotational groundstate. The full kinematics of these processes can be resolved by a position and energy sensitive detection of the reaction products/molecule fragments.

We describe the development of a large-area MMC for position sensitive detection of massive particles with kinetic energies of a few keV. The detector encompasses sixteen slice-shaped large-area absorbers to form a circular whole with a diameter of 36 mm. The temperature sensor is positioned on the outer edge of each absorber. Due to the finite thermal diffusivity in the absorber material, the rise-time of the detector-signal depends on the impact location of the particle.

We compare a numerical analysis for the energy and position dependence of the detector signal to results of recent test measurements where energy was deposited at different positions by LED light pulses as well as x-ray photons delivered by an ^{55}Fe source. For massive particles, potential degradation of instrumental line width as well as energy losses by backscattering, sputtering and lattice damages are discussed using Monte Carlo simulations.

TT 12.4 Mon 15:00 Poster D

Superconducting nanowire single-photon detectors (SNSPDs) on SOI for near-infrared range — •Philipp Trojan[1], Konstantin Ilin[1], Dagmar Henrich[1], Matthias Hofherr[1], Steffen Dörner[1], Alexey Semenov[2], Heinz-Wilhelm Huebers[2,3], and Michael Siegel[1] — [1]Institut für Mikro- und Nanoelektronische Systeme (IMS), Karlsruher Institut für Technologie (KIT) — [2]Institut für Planetenforschung, DLR, Berlin-Adlershof — [3]Institut für Optik und Atomare Physik, Technische Universität Berlin

Superconducting nanowire single-photon detectors are promising devices for photon detectors with high count rates, low dark count rates and low dead times. At wavelengths beyond the visible range, the detection efficiency of today's SNSPDs drops significantly. Moreover, the low absorption in ultra-thin detector films is a limiting factor over the entire spectral range.

Solving this problem requires approaches for an enhancement of the absorption range in feeding the light to the detector element.

A possibility to obtain a better absorption is the use of multilayer substrate materials for photonic waveguide structures.

We present results on development of superconducting nanowire single-photon detectors made from niobium nitride on silicon-on-insulator (SOI) multilayer substrates. Optical and superconducting properties of SNSPDs on SOI will be discussed and compared with the characteristics of detectors on common substrates.

TT 12.5 Mon 15:00 Poster D

Self-Planarized Process for the Fabrication of Josephson Junction Devices — •Michael Merker, Johannes Maximilian Meckbach, Simon Buehler, Konstantin Il'in, and Michael Siegel — Institut für Mikro- und Nanoelektronische Systeme (IMS), Karlsruher Institut für Technologie (KIT), Germany

High performance Josephson junction (JJ) devices require good control of lateral dimensions. Various JJ devices can benefit from sub-μm feature sizes. In our conventional Nb/Al-AlO$_x$/Nb process, the minimum feature size is however limited by the step height of the layers beneath. In order to overcome this constraint, we refined our process, resulting in almost flat surfaces at intermediate processing steps without the need for time consuming chemical-mechanical polishing (CMP). Sub-μm feature sizes can be achieved using electron beam lithography (EBL). Due to the application of mix & match lithography, (combination of EBL and photolithography), the turn-around time is not increased significantly compared to our conventional process.

Transport properties of sub-μm JJs at 4.2 K will be presented. Our JJ process yields excellent quality parameters with sub-μm feature sizes even in the third metal layer, and is therefore very promising for fabricating sub-μm JJs for quantum devices such as SQUIDs or receiver devices.

TT 12.6 Mon 15:00 Poster D

Quasi-optical THz spectroscopy on ultra-thin superconducting films of NbN and TaN. — •Uwe Santiago Pracht[1], Eric Heintze[1], Marc Scheffler[1], Martin Dressel[1], Konstantin Il'in[2], Dagmar Henrich[2], Qiao Guo[2], and Michael Siegel[2] — [1]1. Physikalisches Institut, University of Stuttgart, Germany — [2]Institut für Mikro- und Nanoelektronische Systeme (IMS), Karlsruher Institut für Technologie (KIT), Germany

Ultra-thin films of the conventional superconductors niobium nitride (NbN) and tantalum nitride (TaN) have recently attracted attention for devices such as single-photon detectors. Quasi-optical THz spectroscopy is a particularly suited tool with direct access to superconducting properties, such as the superconducting energy gap, which are necessary for a proper understanding of device performance and for future improvements.

With our THz-spectroscopy approach we measure amplitude and phaseshift of coherent radiation (0.09-1.2 THz) passing through thin-

film systems. We present the performance and possibilities of our experimental set-up, and we apply it to ultra-thin superconducting films of NbN and TaN. We fit the experimental data to weak-coupling BCS theory, and we obtain frequency- and temperature-dependent superconducting properties such as the complex optical conductivity, the complex dielectric function, the energy gap, the penetration depth, and the superfluid density.

TT 12.7 Mon 15:00 Poster D

Niobium Nitride Technology for Josephson Junction Devices — •Johannes Maximilian Meckbach[1], Michael Merker[1], Konstantin Il'in[1], Andreas Häffelin[2], and Michael Siegel[1] — [1]Institut für Mikro- und Nanoelektronische Systeme (IMS), Karlsruher Institut für Technologie (KIT), Hertzstrasse 16, 76187 Karlsruhe, Germany — [2]Institut für Werkstoffe der Elektrotechnik (IWE), Karlsruher Institut für Technologie(KIT), Adenauerring 20b, 76131 Karlsruhe, Germany

Over the last decades Nb/Al-AlO_x/Nb multi-layers have been the primary choice for Josephson junction (JJ) devices such as SIS mixers, SQUIDs and RSFQ. Various applications require high critical-current densities j_c and low sub-gap leakage. Additionally, a large gap-voltage benefits the performance of most devices. Nb/Al-AlO_x/Nb technology is limited in j_c due to an increasing transparency of the barrier with increasing j_c, and the energy-gap of the Nb electrodes poses an upper frequency limit for SIS mixers.

NbN/AlN/NbN multi-layer technology has emerged as an alternative to Nb/Al-AlO_x/Nb. The upper frequency limit of NbN-based SIS mixing element significantly exceeds that of Nb, and AlN-barriers result in higher j_c's at identical thicknesses as compared to AlO_x.

We have developed an *in-situ* fabrication technology for NbN/AlN/NbN multi-layers. We found a clear influence of the sputter parameters on the surface morphology of the NbN electrodes, which directly impacts on the quality of the JJs. Transport properties of JJs on different substrates will be presented.

TT 12.8 Mon 15:00 Poster D

Towards long lived tunable transmon qubit in microstrip geometry — •Jochen Braumüller, Lucas Radtke, Hannes Rotzinger, Martin Weides, and Alexey V. Ustinov — Karlsruhe Institute of Technology (KIT), Physikalisches Institut, 76131 Karlsruhe, Germany

Qubits constitute the main building blocks of a prospective quantum computer. One main challenge is given by short decoherence times. In this work we investigate a transmon qubit based on a superconducting charge qubit with reduced sensitivity to charge noise. This is achieved by operating the qubit at a Josephson to charging energy ratio of about 100. At the same time, a sufficiently large anharmonicity of the energy levels is preserved. The qubit is realized in a 2D geometry based on large capacitor pads being connected by two Josephson junctions in parallel. This split Josephson junction allows the qubit to be tunable in Josephson energy and therefore in resonance frequency. The large area capacitor pads mainly coupled through the substrate and a backside metalization reduce the surface loss contribution. Manipulation and readout of the qubit is mediated by a microstrip resonator coupled to a feedline. We will present resonator and qubit designs together with respective microwave simulations. Preliminary results on circuit fabrication and low temperature measurements will also be discussed.

TT 12.9 Mon 15:00 Poster D

Quantum behavior of a SQUID qubit manipulated with fast pulses — •Samuele Spilla[1], Maria Gabriella Castellano[2], Fabio Chiarello[2], Antonino Messina[1], Rosanna Migliore[3], and Anna Napoli[1] — [1]Dipartimento di Fisica dell'Università di Palermo, Via Archirafi 36, 90123 Palermo, Italy — [2]Istituto Fotonica e Nanotecnologie - CNR, Roma, Italy — [3]Institute of Biophysics, National Research Council, via Ugo La Malfa 153, 90146 Palermo, Italy

A SQUID qubit manipulated with fast variation of the energy potential is analyzed. Varying the potential shape from a single to a double-well configuration, quantum behaviors are brought into light and discussed. We show that the presence of quantum coherences in the initial state of the system plays a central role in the appearance of these quantum effects.

TT 12.10 Mon 15:00 Poster D

Dynamical Coulomb Blockade: From bumpy oscillations to elevator rides — •Selina Rohrer, Vera Gramich, Björn Kubala, Jürgen T. Stockburger, and Joachim Ankerhold — Institut für Theoretische Physik, Universität Ulm, Albert-Einstein-Allee 11, 89069 Ulm, Germany

Recently the photonic side of the dynamical coulomb blockade was explored by measuring the emitted radiation of a dc voltage-biased Josephson junction embedded in a microwave resonator [1]. In order to gain a better understanding of the strong coupling case, we investigate the classical (typically chaotic) dynamics of the system. Extending this dynamics to a Langevin-type description, well-defined dynamical steady states are obtained.

In addition to limit cycles with the Josephson frequency ω_J, we observe marginally damped cycles at subharmonics as well as bifurcations. For very strong coupling between resonator and Josephson junction highly structured, asymmetric limit cycles at low frequencies are observed, which can intuitively be interpreted as "elevator-like" dynamics.

[1] M. Hofheinz et al., PRL 106, 217005 (2011)

TT 12.11 Mon 15:00 Poster D

Observation of Andreev bound states at spin-active interfaces — •Detlef Beckmann[1], Florian Hübler[1,2], Michael Johannes Wolf[1], and Hilbert von Löhneysen[2,3] — [1]KIT, Institut für Nanotechnologie — [2]KIT, Institut für Festkörperphysik — [3]KIT, Physikalisches Institut

We report on high-resolution differential conductance experiments on nanoscale superconductor/ferromagnet tunnel junctions with ultrathin oxide tunnel barriers. We observe subgap conductance features which are symmetric with respect to bias, and shift according to the Zeeman energy with an applied magnetic field. These features can be explained by resonant transport via Andreev bound states induced by spin-active scattering at the interface. From the energy and the Zeeman shift of the bound states, both the magnitude and sign of the spin-dependent interfacial phase shifts between spin-up and spin-down electrons can be determined. These results contribute to the microscopic insight into the triplet proximity effect at spin-active interfaces.

[1] F. Hübler et al., Phys. Rev. Lett. **109**, 087004 (2012).

TT 12.12 Mon 15:00 Poster D

Dynamical Coulomb blockade of the nonlocal conductance in normalmetal/superconductor hybrid structures — •Stefan Kolenda, Michael J. Wolf, and Detlef Beckmann — Institut für Nanotechnologie, KIT, 76021 Karlsruhe, Germany

In normalmetal/superconductor hybrid structures nonlocal conductance is determined by crossed Andreev reflection (CAR) and elastic cotunneling (EC). This was investigated recently both experimentally and theoretically ([1], [2] and references therein). Dynamical Coulomb blockade of EC and CAR was predicted theoretically in [2]. Here we report on experimental investigations of these effects. We found signatures of dynamical Coulomb blockade in local and nonlocal conductance in the normal state. In the superconducting state, we find s-shaped nonlocal differential conductance curves as a function of bias applied on both contacts, as predicted in [2]. These curves were observed for bias voltages both below and above the gap. We compare our results to theory.

[1] J. Brauer et al., Phys. Rev. B **81**, 024515 (2010)
[2] D.S. Golubev and A.D. Zaikin, Phys. Rev. B **82**, 134508 (2010)

TT 12.13 Mon 15:00 Poster D

Electron entanglement in Cooper pair beam splitter with magnetic fields — •Stephan Weiss[1], Jürgen König[1], and Yuval Gefen[2] — [1]Universität Duisburg-Essen and CENIDE, 47048 Duisburg — [2]Department of Condensed Matter Physics, Weizmann Institute of Science, Rehovot 76100, Israel

We develop a theory that suggests the efficient manipulation of entangled electrons provided by a Cooper pair beam splitter. The splitting of coherent electrons forming a spin singlet is present if the superconductor is tunnel coupled to a double quantum dot [1]. In order to probe entanglement, we allow for an inhomogeneous and, in general, non-collinear magnetic field. If the DQD-SC system is embedded in a transport setup, non-local current and noise properties are obtained within the real-time diagrammatic method [2]. As a small parameter we use the hybridization between splitter and normal leads. The tunnel coupling to the superconductor is taken into account nonperturbatively. Furthermore, we provide a detailed investigation of the violation of Bell's inequality for various parameter regimes.

[1] J. Eldridge, M. Governale, and J. König, Phys. Rev. B **82** 184507,

(2010)
[2] M. Governale, M. Pala, and J. König, Phys. Rev. B **77** 134513, (2008)

TT 12.14 Mon 15:00 Poster D

Manifestly Non-Gaussian Fluctuations in Superconductor-Normal Metal Tunnel Nanostructures — •Matti Laakso[1,2], Tero Heikkilä[2], and Yuli Nazarov[3] — [1]Institut für Theorie der Statistischen Physik, RWTH Aachen University, Aachen, Germany — [2]Low Temperature Laboratory, Aalto University, Espoo, Finland — [3]Kavli Institute of Nanoscience, Delft University of Technology, Delft, The Netherlands

Recently, temperature fluctuation statistics has been studied in non-interacting islands [1] and overheated single-electron transistors [2]. We propose [3] a mesoscopic setup which exhibits strong and manifestly non-Gaussian fluctuations of energy and temperature when suitably driven out of equilibrium. The setup consists of a normal metal island (N) coupled by tunnel junctions (I) to two superconducting leads (S), forming a SINIS structure, and is biased near the threshold voltage for quasiparticle tunneling, $eV \approx 2\Delta$. The fluctuations can be measured by monitoring the time-dependent electric current through the system, which makes the setup suitable for the realization of feedback schemes which allow to stabilize the temperature to the desired value.

[1] T.T. Heikkilä and Y.V. Nazarov, Phys. Rev. Lett. **102**, 130605 (2009)
[2] M.A. Laakso, T.T. Heikkilä, Y.V. Nazarov, Phys. Rev. Lett. **104**, 196805 (2010)
[3] M.A. Laakso, T.T. Heikkilä, Y.V. Nazarov, Phys. Rev. Lett. **108**, 067002 (2012)

TT 12.15 Mon 15:00 Poster D

Resummation approach to interacting quantum dots in contact with superconducting leads — David Futterer[1], •Jacek Swiebodzinski[1], Michele Governale[2], and Jürgen König[1] — [1]Theoretische Physik, Universität Duisburg-Essen and CENIDE, 47048 Duisburg, Germany — [2]School of Chemical and Physical Sciences and MacDiarmid Institute for Advanced Materials and Nanotechnology, Victoria University of Wellington, PO Box 600, Wellington 6140, New Zealand

The simultaneous occurrence of Coulomb interactions and superconducting correlations combined with a possible non-equilibrium situation makes interacting quantum dots (QD) that are coupled to superconductors a fascinating field of research. To account for all these features in a theoretical description proves however challenging and one has to resort to specific approximations or numerically demanding solving schemes. Here, we consider a QD coupled to one normal and two superconducting leads. We first calculate the transport properties of the system using a perturbative expansion in the dot-normal reservoir coupling. We allow for a finite superconducting gap Δ by performing a $1/\Delta$ expansion. We then introduce an approach based on partial resummation of diagrams to infinite order in the coupling and calculate the Andreev bound states of the system. The results on the latter show very good agreement with those obtained by the computationly more demanding numerical renormalization group method.

TT 12.16 Mon 15:00 Poster D

Subgap-anomalies in 3-terminal hybrid superconductor/ normal metal nanostructures — •Andreas H. Pfeffer[1,2], Hervé Courtois[3], and François Lefloch[1] — [1]CEA/INAC/SPSMS, Grenoble, France — [2]Nanoscience Foundation (RTRA), Grenoble, France — [3]CNRS/Néel Institute and UJF, Grenoble, France

We have studied the electronic transport properties of three terminal superconductor (S) - normal metal (N) - superconductor (S) nanodevices using a new SQUID-based experimental set-up working at very low temperature (30 mK) and dedicated for high sensitive conductance and current noise correlations measurements [1,2]. In a geometry where a T-shaped normal metal (Cu) is connected to three superconducting reservoirs (Al), new subgap anomalies appear in the differential conductance for specific values of the chemical potential applied to the superconductors. The most emphasized line appears when two superconductors (collectors) are biased at opposite voltage with respect to the third superconducting electrode (injector). This anomaly is consistent with the prediction of non-local quartets as the result of double crossed Andreev reflections (dCAR) [3]. In this particular process, a Cooper pair originating from the injector is split in two quasiparticles that recombine into Cooper pairs in each of the two collectors. Additional features appear for other integer voltage ratios and could be attributed to higher order processes of dCAR. The mechanism of non-local quartet opens perspectives toward a new generation of entanglers.

[1] PRL **107**, 077005 (2011)
[2] RSI **83**, 115107 (2012)
[3] PRL **106**, 257005 (2011)

TT 12.17 Mon 15:00 Poster D

Magnetization-Orientation Dependence of the Superconducting Transition in AF-F/S/F and S/F/F-AF Type Spin Valve Heterostructures — •Vladimir Zdravkov[1,2], Daniel Lenk[1], Jan Kehrle[1], Günter Obermeier[1], Aladin Ullrich[1], Claus Müller[1], Hans-Albrecht Krug von Nidda[1], Roman Morari[2], Anatoli Sidorenko[2], Lenar Tagirov[3], Siegfried Horn[1], and Reinhard Tidecks[1] — [1]Institut für Physik, Universität Augsburg, D-86159 Augsburg, Germany — [2]D. Ghitsu Institute of the Electronic Engineering and Nanotechnologies ASM, MD 2028 Kishiniev, Moldova — [3]Solid State Physics Department, Kazan Federal University, 420008 Kazan, Russia

In F/S/F spin valve core structures, i.e. $Cu_{41}Ni_{59}/Nb/Cu_{41}Ni_{59}$ systems, deposited on an antiferromagnetic CoOx layer, or with such a layer on top, critical temperature oscillations and reentrant superconductivity are observed, which can be well described by the theory. Introducing a Co sub-layer yields exchange bias effects, which influence the magnetic field dependence of the superconducting transition. Aging effects are studied, which especially alter the transparency of the lower F/S interface, resulting in a change of the behavior of the transition temperature as a function of the ferromagnetic layer thickness from extinction, over reentrant, to oscillating.

The results are discussed in comparison to the S/F/F-AF triplet spin valve effect in a $Nb/Cu_{41}Ni_{59}$/nc-Nb/Co/CoO_x system, where nc-Nb acts as a normal conducting spacer to decouple the ferromagnetic layers.

TT 12.18 Mon 15:00 Poster D

Size dependence of the electric transport properties of thin TiN-films at the superconducting side of the SIT — •Klaus Kronfeldner[1], Tatyana Baturina[2], and Christoph Strunk[1] — [1]Institute for Experimental and Applied Physics, University of Regensburg, 93040 Regensburg, Germany — [2]A. V. Rzhanov Institute of Semiconductor Physics SB RAS, Novosibirsk 630090, Russia

We investigate the electric transport at the superconducting side of the superconductor-insulator transition (SIT) in square-shaped thin TiN-films and its dependence on their lateral size. The resistance at room temperature was tuned by heating up the sample in air, in order to approach the SIT. We revealed a size-dependent magnetoresistance. For the smaller samples a very small magnetic field is sufficient to induce a finite resistance. The larger samples remain superconducting nearly up the nominal critical field ($B \approx 2.8T$) of the TiN-material.

TT 12.19 Mon 15:00 Poster D

Nonequilibrium Dynamics of Nanoscaled Superconductors — •Peter Kettmann[1], Thomas Papenkort[1], Mihail Croitoru[2], Vollrath Martin Axt[2], and Tilmann Kuhn[1] — [1]Institut für Festkörpertheorie, Universität Münster, Wilhelm-Klemm-Str. 10 — [2]Theoretische Physik III, Universität Bayreuth

We theoretically investigate the nonequilibrium dynamics of nanoscaled superconductors. The excitation is achieved by a change of the coupling constant of the electrons. The dynamics are calculated using the Bogoliubov-de Gennes equation for inhomogeneous superconductors. When studying systems that are strongly confined in all three spatial directions we find that the order parameter, the central quantity of the superconductor, oscillates in time. This oscillation consists of many discrete frequencies which mainly correspond to the eigenenergies of the quasiparticles of the system. By increasing the size of the superconductor in one direction we show that the dynamics becomes similar to the one known from the homogeneous case. This is given by a damped oscillation of the order parameter with one collective mode [1]. By using a linear approximation of the equations of motion we show that this behavior can be explained in terms of a sum of independent oscillators dephasing in time.

[1] Papenkort et al., PRB 78, 132505 (2008)

TT 12.20 Mon 15:00 Poster D

Quasiparticle interference in non-centrosymmetric super-

conductors — •Johannes Hofmann[1,2], Raquel Queiroz[1], Andreas P. Schnyder[1], and Dirk Manske[1] — [1]Max Planck Institut für Festkörperforschung, Stuttgart, Germany — [2]Julius-Maximilians-Universität Würzburg, Würzburg, Germany

Motivated by recent point contact Andreev reflection measurements on BiPd [1], we study the appearance of topologically protected surface states in non-centrosymmetric superconductors. We determine the signatures of these surface states in quasiparticle interference experiments and show that Fourier transform scanning tunneling spectroscopy (FT-STS) can give direct information about the momentum-space structure of these surface states. In particular, we find that FT-STS allows to distinguish among different types of topological surface states, such as zero-energy flat bands, arc surface states, and helical Majorana modes [2-4]. We investigate non-centrosymmetric superconductors with different point-group symmetries and consider both non-magnetic and magnetic impurity scatterers. In the case of non-magnetic s-wave scatterers, a simple interperation of the quasiparticle interference pattern in terms of the joint density of states is derived.

[1] M. Mondal et al., Phys. Rev. B 86, 094520 (2012).
[2] A. P. Schnyder and S. Ryu, Phys. Rev. B 84, 060504(R) (2011).
[3] P. M. R. Brydon, A. P. Schnyder, and C. Timm, Phys. Rev. B 84, 020501(R) (2011)
[4] A. P. Schnyder, P. M. R. Brydon, and C. Timm, Phys. Rev. B 85, 024522 (2012).

TT 12.21 Mon 15:00 Poster D

Coulomb interaction in Eliashberg theory of superconductivity. — •Arkady Davydov and Antonio Sanna — Max-Planck-Institute of Microstructure Physics, Halle (Saale), Germany

The Eliashberg theory [1] of superconductivity allows to describe materials with strong pairing interaction. In the non magnetic case it leads to a system of coupled integral multidimensional equations. Computational costs are usually reduced by an isotropic limit [2], and by restricting the Coulomb interaction to the use of one single parameter, μ^*, often chosen to give the experimental T_c. In this work we present the parameter-free approach in which the screened Coulomb interaction fully accounted within the Random Phase Approximation, entering the Eliashberg's equations on the same footing as the phononic interaction. We will compare this approach with Density Functional Theory for Superconductors [3, 4] where the corresponding approximation leads to a good agreement with experiments.

[1] G.M. Eliashberg, Sov. Phys. JETP 11, 696 (1960)
[2] D.J. Scalapino, Phys. Rev. 148, 263 (1966)
[3] L.N. Oliveira, E.K.U. Gross, Phys. Rev. Lett. 60, 2430 (1988)
[4] M. Lüders, PRB 72, 024545 (2005)

TT 12.22 Mon 15:00 Poster D

Nematic quantum critical behaviors in high-temperature supreconductors — •Jing Wang[1,2], Guo-Zhu Liu[1], Jing-Rong Wang[1,3], and Hagen Kleinert[4] — [1]University of Science and Technology of China, Hefei, China — [2]Max Planck Institute, Stuttgart, Germany — [3]Max Planck Institut, Dresden, Germany — [4]Freie Universität Berlin, Berlin, Germany

In the past decade, there have been a number of experimental signatures pointing towards the presence of electronic nematic phase in some high-temperature superconductors [1]. On the basis of these experiments, a nematic quantum phase transition is expectd to exist in the d-wave superconducting dome [2,3]. The critical nematic fluctuation interacts strongly with the gapless nodal quasiparticles, which leads to highly unusual properties. We examine the stability of the nematic quantum critical point against various quenched disorders by means of renormalization group approach [4,5]. We also study the influence of critical nematic fluctuation on some observable quantities, and predict that superconductivity is suppressed at the nematic quantum critical point [4,5].

[1] E. Fradkin et al., Annu. Rev. Condens. Matter Phys. 1, 153 (2010)
[2] E.-A. Kim et al., Phys. Rev. B 77, 184514 (2008)
[3] Y. Huh and S. Sachdev, Phys. Rev. B 78, 064512 (2008)
[4] J. Wang, G.-Z. Liu, and H. Kleinert, Phys. Rev. B 83, 214503 (2011)
[5] G.-Z. Liu, J.-R. Wang, and J. Wang, Phys. Rev. B 85, 174525 (2012)

TT 12.23 Mon 15:00 Poster D

In-plane upper critical field of d-wave superconductors — •Wang Jing-Rong[1,2], Liu Guo-Zhu[1], Ribeiro Pedro[2], and Kirchner Stefan[2,3] — [1]Department of Modern Physics, University of Science and Technology of China, Hefei, Anhui 230026, P. R. China — [2]Max Planck Institute for the Physics of Complex Systems, 01187 Dresden, Germany — [3]Max Planck Institute for Chemical Physics of Solids, 01187 Dresden, Germany

Determining the full gap symmetry of unconventional superconductors is an important but difficult task. One experimental method to determine the gap symmetry is to measure the angular dependence of the in-plane upper critical field. Due to their large effective mass, heavy fermion superconductors are usually Pauli limited but also orbital coupling contributes to H_{c2}. Recent experiments on $CeCu_2Si_2$ indicate that the in-plane upper critical field exhibits a number of interesting behaviors. Motivated by these experiments, we systematically study the angular independence of the upper critical field including both orbital coupling and Zeeman coupling. We compare our theoretical results with the relevant experiments[1].

[1] H. Vieyra et al. PRL **106**, 207001 (2011).

TT 12.24 Mon 15:00 Poster D

Eight-band model for iron arsenides: Functional renormalization group study — •Julian Lichtenstein[1], Stefan Maier[1], and Carsten Honerkamp[1,2] — [1]Institute for Theoretical Solid State Physics, RWTH Aachen University, Germany — [2]JARA - Fundamentals of Future Information Technology

We analyze an effective two-dimensional eight-band model [1] for LaOFeAs and SmOFeAs within a functional renormalization group (fRG) approach. Upon varying parameters from LaOFeAs to SmOFeAs, we find an increasing critical scale for superconducting instabilities, while the critical scales of spin-density wave ordering change only by a small amount.

[1] O. K. Andersen and L. Boeri, Ann. Phys. (Berlin) **523**, 8 (2011)

TT 12.25 Mon 15:00 Poster D

Quasiparticle scattering rates in iron pnictides from the functional renormalization group — •Guido Klingschat[1], Julian Lichtenstein[1], and Carsten Honerkamp[1,2] — [1]Institute for Theoretical Solid State Physics, RWTH Aachen University, 52056 Aachen, Germany — [2]JARA - Fundamentals of Future Information Technology

We use a function renormalization group approach [1] to compute the quasiparticle scattering rate in eight-band models [2] for iron pnictide superconductors. This way we obtain the anisotropy and temperature dependences of the scattering rates above the critcial scales towards long-range orderings. We study material-specific variations and compare the scattering rate anisotropies with the predicted gap anisotropies in the superconducting state.

[1] C. Honerkamp, Eur. Phys. J. B **21**, 81 (2001)
[2] O. K. Andersen and L. Boeri, Ann. Phys. (Berlin) **523**, 8 (2011)

TT 12.26 Mon 15:00 Poster D

Evolution of the multiband RKKY interaction: Application to iron pnictides and chalcogenides — •Alireza Akbari[1], Peter Thalmeier[1], and Ilya Eremin[2] — [1]Max Planck Institute for the Chemical Physics of Solids, 01187 Dresden, Germany — [2]Theoretische Physik III, Ruhr-Universität Bochum, 44780, Bochum, Germany

The indirect RKKY interaction in iron pnictide and chalcogenide metals is calculated for a simplified four bands Fermi surface (FS) model. We investigate the specific multi-band features and show that distinct length scales of the RKKY oscillations appear. In the paramagnetic state the interaction is spin isotropic however, in the spin density wave (SDW) phases, the RKKY interaction maps into an effective anisotropic XXZ-type Heisenberg exchange model. The anisotropy originates from the breaking of the spin-rotational symmetry induced by the SDW order and its strength depends on the size of the SDW-gap and the structure of the folded Fermi surface. For the regular lattice of the local moments, the generalized RKKY interaction is defined in momentum space. We consider its momentum dependence in paramagnetic and SDW phases, discuss its implications for the possible type of magnetic order and compare it to the results obtained from more realistic tight-binding type Fermi surface model. Our finding can give important clues on the magnetic ordering of the 4f- iron based superconductors.

[1] A. Akbari, I. Eremin, and P. Thalmeier, Phys. Rev. B 84, 134513 (2011)
[2] A. Akbari, P. Thalmeier, and I. Eremin (Preprint)

TT 12.27 Mon 15:00 Poster D

Nodal spin density wave in iron-based superconductors — •Felix Ahn and Ilya M. Eremin — Institut für Theoretische Physik III, Ruhr-Universität Bochum, D-44801 Bochum, Germany

We analyze the competition of SDW and SC orders in the iron-based superconductors, taking into account the orbital matrix elements. We find that the SDW order necessarily possesses the nodal structure as a result of angular dependence of the Fermi-liquid interactions. To obtain the phase diagram we solve the system of coupled mean-field gap equations, which describes the competition between SDW and s++ or s+− superconductivity. We revisit the result, obtained previously, for the constant SDW gap. We further discuss the role played by the spin-orbit coupling.

TT 12.28 Mon 15:00 Poster D

Experimental setup for magneto-optical measurements on iron pnictides — •David Neubauer, Sina Zapf, Shuai Jiang, Dan Wu, and Martin Dressel — 1. Physikalisches Institut, Universität Stuttgart, Germany

The role of magnetism for high-T_c superconductivity is still under hot debate. $EuFe_2(As_{1-x}P_x)_2$ is a peculiar member of the iron pnictides, as it shows a local ordering of the Eu^{2+} moments at low temperatures (≈20K) besides the Fe^{2+} spin density wave. This leads to exceptional phenomena such as the re-entrance of superconductivity below the Eu magnetic ordering temperature or field induced superconductivity. Magneto-optical measurements on $EuFe_2(As_{1-x}P_x)_2$ will give further insight to the role magnetism plays on the electronic properties of iron pnictides. We are currently setting up an experiment combining the 12T "Spectromag 4000" (Oxford Instruments) with the "IFS 113v " spectrometer (Bruker). The setup will also allow *in situ* gold evaporation in order to account for surface roughness. We present the overall setup and discuss the design of a stage for optical access to the magnet in Voigt- and Faraday-geometry.

TT 12.29 Mon 15:00 Poster D

Mössbauer and muon spin relaxation investigation of magnetic and superconducting properties of $Ca_{1-x}Na_xFe_2As_2$ — •Philipp Materne[1], Sirko Bubel[1], Hemke Maeter[1], Rajib Sarkar[1], Luminita Harnagea[2], Sabine Wurmehl[2], Bernd Büchner[2], Hubertus Luetkens[3], and Hans-Henning Klauss[1] — [1]Institut für Festkörperphysik, Technische Universität Dresden, 01062 Dresden, Germany — [2]IFW Dresden, Postfach 270016, 01171 Dresden, Germany — [3]Paul-Scherrer-Institut, 5232 Villigen, Switzerland

The antiferromagnetic parent compound, $CaFe_2As_2$, shows a supression of the spin density wave and a subsequent superconducting state upon partial substitution of Ca by Na. Along the substitution series, superconducting transition temperatures up to ≈35 K were found. We studied the electronic phase diagram of $Ca_{1-x}Na_xFe_2As_2$ using Mössbauer spectroscopy and muon spin relaxation experiments. We have analyzed the data in terms of magnetic and superconducting properties and possible coexistence of superconductivity and spin density wave order. We compared our results with recently published data of $Ba_{1-x}Na_xFe_2As_2$ [1].

[1] H. Maeter *et al.*, arXiv:1210.6881

TT 12.30 Mon 15:00 Poster D

Ultrasonic investigations on the iron-based superconductor $Ba(Fe_{1-x}Co_x)_2As_2$ — •Stephan Knöner[1], Bernd Wolf[1], Pham Thanh Cong[1], Thomas Wolf[2], and Michael Lang[1] — [1]Physikalisches Institut, Goethe-Universität, D-60438 Frankfurt (M) — [2]Karlsruhe Institute of Technology, D-76131 Karlsruhe

The simultaneous occurrence of a structural transition and long-range magnetic order in the proximity to the superconducting phase in iron-based superconductors raises the question whether the spin or the lattice degrees of freedom manifest the dominant low-energy excitations in the systems which are relevant for the superconductivity. Based on ultrasonic investigations both scenarios have been discussed in the literature. Ultrasonic experiments on $Ba(Fe_{1-x}Co_x)_2As_2$ showed a huge softening of the transverse elastic constant c_{66} related to the structural tetragonal to orthorhombic/antiferromagnetic phase transition at T_S/T_N and a subsequent hardening upon entering the superconducting state at T_{sc}. We present measurements of the c_{33} and $1/2(c_{11}+c_{12}+2c_{66})$-mode together with the ultrasonic attenuation on $Ba(Fe_{1-x}Co_x)_2As_2$ single crystals with x=0 and x=0.06. In the undoped compound, two, slightly separated, step-like anomalies of nearly similar size, corresponding to the structural/magnetic transition at T_S/T_N are clearly visible in the c_{33}-mode. According to our characterization measurements by resistivity and susceptibility, our crystal with x=0.06 shows neither a structural nor a magnetic transition but is superconducting at T_{sc}=24 K. Here the superconducting transition is visible in the c_{33} as well as in the $1/2(c_{11}+c_{12}+2c_{66})$-mode.

TT 12.31 Mon 15:00 Poster D

Hydrostatic-Pressure Tuning of Magnetic, Nonmagnetic and Superconducting States in Annealed $Ca(Fe_{1-x}Co_x)_2As_2$ — •Sebastian Köhler[1], Elena Gati[1], Daniel Guterding[1], Stephan Knöner[1], Sheng Ran[2], Sergey L. Bud'ko[2], Paul C. Canfield[2], and Michael Lang[1] — [1]Physikalisches Institut, J.W. Goethe-Universität, SPP 1458, 60438 Frankfurt (Main), Germany — [2]Ames Laboratory, Department of Physics and Astronomy, Iowa State University, Ames, Iowa 50011, USA

Iron-based superconductors exhibit rich phase diagrams including tetragonal, orthorhombic/antiferromagnetic (o/afm) and superconducting (sc) states. For the AFe_2As_2 (122) (A = Ba, Sr and Ca) compounds, yet another, nonmagnetic collapsed-tetragonal (cT) phase has been observed at high pressure. It has been shown that for Co-doped Ca 122 single crystals, a postgrowth thermal treatment at an annealing temperature T_a can be used to tune the ground state of the system [1]. Recently we provided evidence that T_a mimics the effect of hydrostatic pressure by demonstrating that for properly heat-treated $Ca(Fe_{1-x}Co_x)_2As_2$ the salient ground states can be accessed all in one sample by applying small, truly hydrostatic pressure [2]. We present results of electrical resistance and magnetic susceptibility under pressure for this compound with different combinations of x/T_a. The obtained p-T phase diagrams indicate that preserving fluctuations associated with the o/afm transition to low enough temperatures is vital for sc to form here.

[1] S. Ran et al., Phys. Rev. B **83**, 144517 (2011)
[2] E. Gati et al., arXiv:1210.5398 (2012)

TT 12.32 Mon 15:00 Poster D

Electronic structure of single-crystalline $Sr(Fe_{1-x}Co_x)_2As_2$ probed by x-ray absorption spectroscopy: Evidence for effectively isovalent substitution of Fe^{2+} by Co^{2+} — •Michael Merz[1], Thomas Wolf[1], Peter Nagel[1], Felix Eilers[1], Peter Schweiss[1], Hilbert von Löhneysen[1,2], and Stefan Schuppler[1] — [1]Institut für Festkörperphysik, Karlsruhe Institute of Technology, 76021 Karlsruhe, Germany — [2]Physikalisches Institut, Karlsruhe Institute of Technology, 76131 Karlsruhe, Germany

The substitutional dependence of valence and spin-state configurations of $Sr(Fe_{1-x}Co_x)_2As_2$ (x = 0, 0.05, 0.11, 0.17, and 0.38) is investigated with near-edge x-ray absorption fine structure at the $L_{2,3}$ edges of Fe, Co, and As. The present data provide direct spectroscopic evidence for an effectively isovalent substitution of Fe^{2+} by Co^{2+}, which is in contrast to the widely assumed Co-induced electron-doping effect. Moreover, the data reveal that not only does the Fe valency remain completely unaffected across the entire doping range, but so do the Co and As valencies as well. The data underline a prominent role of the hybridization between (Fe,Co) $3d_{xy}$, d_{xz}, d_{yz} orbitals and As $4s/4p$ states for the band structure in $A(Fe_{1-x}Co_x)_2As_2$ and suggest that the covalency of the (Fe,Co)-As bond is a key parameter for the interplay between magnetism and superconductivity.

TT 12.33 Mon 15:00 Poster D

Investigation on KFe_2As_2 single crystals by means of X-ray spectroscopy — •Anna Buling[1], Nikolay Skorikov[2], Aswartham Saicharan[3], Sabine Wurmehl[3], Bernd Büchner[3], and Manfred Neumann[1] — [1]Department of Physics, University of Osnabrueck, Barbarastr. 7, D-49069 Osnabrueck, Germany — [2]Institute of Metal Physics, Russian Academy of Sciences-Ural Division, 620219 Yekaterinburg, Russia — [3]IFW Dresden, PF 270116, D-01171 Dresden, Germany

Soon after superconductivity was found in fluorine doped LaOFeAs, the new AFe_2As_2 familiy of pnictide superconductors without the LaO spacer layers was discovered.
KFe_2As_2 is an endpoint in the $Ba_{1-x}K_xFe_2As_2$ system and takes a special role among the other *122* and *1111* Fe pnictides due to its low T_c around 3.7 K, the lack of the typical orthorhombic structural transition and some other diverse properties. We report on a detailed investigation of the electronic structure of KFe_2As_2 *(K122)* single crystals by means of X-ray spectroscopy completed by density functional theory (DFT) calculations. These results will be compared with fur-

ther already investigated *Ba122* compounds.

TT 12.34 Mon 15:00 Poster D

Signatures of unconventional superconductivity in dI/dV characteristics — •Lars Elster and Ewelina Hankiewicz — Institut für Theoretische Physik, Universität Würzburg, Am Hubland, 97074 Würzburg

We study the dI/dV characteristics of superconductors with different order parameters treating normal state - insulator - superconductor (NIS) junctions within the Bogoliubov-de Gennes (BdG) formalism. The dI/dV characteristics are calculated from the coefficients of Andreev and normal reflections at the interface between normal and superconducting phases treating the insulator as a Dirac-delta like potential barrier. In particular, we find that topological superconductors with broken time-reversal symmetry (BTRS) (e.g. d+is order parameter) show a zero bias peak splitting in the nodal direction, which allows to distinguish them from their non-topological counterparts. Therefore the dI/dV characteristic is a powerful tool in probing the pairing potential of unconventional superconductors, and our predictions can be verified by scanning tunneling microscopy.

TT 12.35 Mon 15:00 Poster D

Josephson currents and resonances observed in STM experiments at milli-Kelvin temperatures — •Berthold Jäck[1], Matthias Eltschka[1], Maximilian Assig[1], Markus Etzkorn[1], Christian R. Ast[1], and Klaus Kern[1,2] — [1]Max-Planck Institute for Solid State Research, D-70569 Stuttgart — [2]Ecole Polytechnique Fédérale de Lausanne, CH-1015 Lausanne

Superconducting tunnel junctions allow for the detailed investigation of various tunneling regimes. Besides the superconducting quasi-particle tunneling, new tunneling paths such as the Josephson effect and Andreev reflections open up as the tunneling barrier is decreased. These processes manifest themselves as new structures within the gap of the superconducting quasi-particle density of states. We investigated these sub-gap structures in a Vanadium-Vanadium tunnel junction by using a Scanning Tunneling Microscope (STM) operating at 15 mK. One of the main advantages of using an STM setup is the very precise control of the tunneling resistance and hence the superconductor's coupling, which is a central property of the tunneling processes. We observe harmonic sub-gap features at energies of about 100 μeV which do not originate from Andreev reflections. Their peak positions neither depend on the superconductor's coupling nor on magnetic fields, but change for different Vanadium tips. We will discuss these experimental findings in the framework of low-impedance tunneling junctions and Josephson junctions coupled to an electro-magnetic environment.

TT 12.36 Mon 15:00 Poster D

STM/STS Study on Co-doped NaFeAs superconductor — •pranab kumar nag[1], danny baumann[1], ronny schlegel[1], rico pohle[1], martha scheffler[1,2], torben hänke[1], robert beck[1], saicharan aswartham[1], sabine wurmehl[1], bernd büchner[1,2], and christian hess[1] — [1]Institut für Festkörperforschung IFW Dresden, — [2]Institut für Festkörperphysik TU Dresden

We have performed scanning tunneling microscopy/spectroscopy measurements on superconducting Co-doped NaFeAs as a function of temperature. After cleaving at low temperature and cryogenic vacuum we were able to investigate the electronic structure of the material by tunneling spectroscopy. The tunneling spectra (dI/dV) reveal several gap-like features near the Fermi level. We compare these result with recent data on LiFeAs.

TT 12.37 Mon 15:00 Poster D

Specific heat measurements of single-crystalline iron superconductors $K_{1-x}Na_xFe_2As_2$ and of Li_2ZrCuO_4 down to 10 mK — •Patrick Vogt[1], Andreas Reifenberger[1], Mahmoud Abdel-Hafiez[2], Sai Aswartham[2], Sabine Wurmehl[2], Marius Hempel[1], Stefan-Ludwig Drechsler[2], Bernd Büchner[2], Andreas Fleischmann[1], Christian Enss[1], and Rüdiger Klingeler[1] — [1]Kirchhoff-Institute for Physics, University of Heidelberg, D-69120 Heidelberg, Germany — [2]Leibniz-Institute for Solid State and Materials Research, IFW-Dresden, D-01171 Dresden, Germany

Specific heat studies down to very low temperatures are applied to study electronic properties in the superconducting phase of $K_{1-x}Na_xFe_2As_2$ and low-energy excitations in the quasi-one-dimensional quantum antiferromagnet Li_2ZrCuO_4. A quasi-adiabatical heat-pulse method including the τ_2-effect yields specific heat data on $K_{1-x}Na_xFe_2As_2$ single crystals with different doping levels down to 10 mK. The data show clear evidence for a T^2-term in specific heat providing evidence for line nodes in the superconducting order parameter. For insulating Li_2ZrCuO_4, a continuous dual-slope method is applied which implies linearly-in-temperature increasing specific heat below 1 K superimposed by an anomaly centered at 60 mK. The anomalously large slope in the linear regime highlights the relevance of quantum fluctuations of presumably magnetic nature.

TT 12.38 Mon 15:00 Poster D

Optical study of LiFeAs — •A. V. Pronin[1], R. P. S. M. Lobo[2], G. Chanda[1], J. Wosnitza[1], S. Kasahara[3], T. Shibauchi[3], and Y. Matsuda[3] — [1]Dresden High Magnetic Field Laboratory (HLD), Helmholtz-Zentrum Dresden-Rossendorf, 01314 Dresden, Germany — [2]LPEM, ESPCI-ParisTech, CNRS, UPMC, 10 rue Vauquelin, 75231 Paris, Cedex 5, France — [3]Department of Physics, Kyoto University, Kyoto 606-8502, Japan

LiFeAs is unique among the iron-based superconductors in that it is superconducting without carrier doping and the residual resistivity ratio is very high. Thus, the determination of the superconducting gap symmetry is not complicated by the material defects. Various spectroscopic and thermodynamic measurements suggest an isotropic gap without nodes. However, no optical observations of the gap have been reported in LiFeAs. Here, we present a broad-band optical investigation of LiFeAs and discuss the frequency and temperature behavior of its complex conductivity.

TT 12.39 Mon 15:00 Poster D

Processing of insulation barriers for the development of tunneling junctions based on pnictide superconductors — •Manuel Monecke, Stefan Schmidt, Sebastian Döring, Martin Feltz, Noor Ali Hasan, David Reifert, Frank Schmidl, and Paul Seidel — Friedrich-Schiller-Universität Jena, Institut für Festkörperphysik, Helmholtzweg 5, 07743 Jena, Germany

Josephson junctions are an excellent tool for the investigation on pnictide superconductors, especially for the understanding of the transport mechanisms in such materials. For the preparation of those Josephson junctions it is important to have high resistance insulating tunneling barriers because the measurements are more purposeful than measurements with low resistance conductive barriers. Metal (e.g. gold) as barrier material has a very low resistance even at the maximum layer thickness. Therefore, disturbing effects like Andreev reflection become significant. Because of these issues it is highly important to study these tunnel barrier materials, their electrical properties and deposition processes. We present initial investigations on the deposition of sputtered oxide tunnel barriers and their properties. Furthermore, we discuss interface effects between base electrode, barrier, and cover electrode.

This work was partially supported by DFG under project no. SE 664/15-1, the DAAD, EU project IRON-SEA no. FP7-283141 and the Landesgraduiertenförderung Thüringen.

TT 12.40 Mon 15:00 Poster D

Josephson junctions based on pnictide superconductors — •Martin Feltz[1], Stefan Schmidt[1], Sebastian Döring[1], David Reifert[1], Sandra Gottwals[1], Noor Ali Hasan[1], Manuel Monecke[1], Frank Schmidl[1], Kazumasa Iida[2], Fritz Kurth[2], Bernhard Holzapfel[2], and Paul Seidel[1] — [1]Friedrich-Schiller-Universität Jena, Institut für Festkörperphysik, Helmholtzweg 5, 07743 Jena, Germany — [2]IFW Dresden, Institute for Metallic Materials, Helmholtzstrasse 20, 01069 Dresden, Germany

Josephson junctions are a powerful tool for understanding more about the physical behaviour of pnictide superconductors. We built different kinds of Josephson junctions based on pnictide thin films. Planar junctions, edge type junctions, and junctions on bicrystalline substrates were prepared. We present manufacturing techniques and also the electronical properties of the different junctions and compare them. The measurement of I-V-characteristics show a strong excess current. We have to mind this when calculating the I_cR_N product. The effective I_cR_N values are 6.5μV for the grain boundary junction, 7.9μV for the planar structure, and 7.5μV for the edge junction.

This work was partially supported by the EU within IRON-SEA (project no. FP7-283141), DFG within SPP 1458 (projects SE 664/15-1 and HA 5934/1-1), the DAAD and the Landesgraduiertenförderung Thüringen.

[1] S. Schmidt et al. IEEE-TAS (2012), accepted [arXiv:1211.3879]

TT 12.41 Mon 15:00 Poster D

Studies on the processing of Ba-122 single crystals for the development of tunnel junctions — •David Reifert[1], Stefan Schmidt[1], Sebastian Döring[1], Martin Feltz[1], Sandra Gottwals[1], Noor Ali Hasan[1], Manuel Monecke[1], Thomas Wolf[2], Frank Schmidl[1], and Paul Seidel[1] — [1]Friedrich-Schiller-Universität Jena, Institut für Festkörperphysik, Helmholtzweg 5, 07743 Jena, Germany — [2]Karlsruhe Institute of Technology, Institut für Festkörperphysik, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany

The investigation of the superconducting properties of iron-based single crystals is important for the understanding of transport mechanisms responsible for superconductivity in those materials. Tunnel junctions are necessary in order to realize phase-sensitive measurement geometries for the investigation of the order parameter symmetry. To fabricate such tunnel junctions on Co-doped $BaFe_2As_2$(Ba-122) single crystals, which were produced with a self-flux method, we had to solve several issues. Using thin film technology requires high quality surfaces, so we show the results of several planarization techniques e.g. chemical mechanical polishing, ion beam smoothing, and crystal cleaving. Finally, we present first electrical measurements on photolithographically patterned Ba-122 single crystals.

This work was partially supported by DFG within SPP 1458 under project no. (SE 664/15-1), the German Academic Exchange Service (DAAD), and the Landesgraduiertenförderung Thüringen.

TT 12.42 Mon 15:00 Poster D

Conductance spectra investigations of ironarsenide superconductor in planar junctions — •Sandra Gottwals[1], Sebastian Döring[1], Stefan Schmidt[1], Noor Ali Hasan[1], Frank Schmidl[1], Fritz Kurth[2], Kazumasa Iida[2], Bernhard Holzapfel[2], Ingolf Mönch[3], and Paul Seidel[1] — [1]Friedrich-Schiller-Universität Jena, Institut für Festkörperphysik, Helmholtzweg 5, 07743 Jena — [2]IFW Dresden, Institut für metallische Werkstoffe, Helmholtzstraße 20, 01069 Dresden — [3]IFW Dresden, Institute for Integrative Nanoscience, Helmholtzstraße 20, 01069 Dresden

To investigate the properties of iron-based superconductor, we used Andreev reflection studies on planar hybrid SNS' junctions, based on Ba-122 (S) thin films with gold layer (N) and a Pb counter electrode (S'). I-V- and differential characteristics were measured at different temperatures of each electrode as well as the junction itself. It could be noticed that both electrodes significantly effect the junction spectra due to an additional series resistance. This resistance occurs for lead at T>7.2 K and is constant, while for Ba-122 it is strongly nonlinear and suspected to be caused by the underlaying Fe buffer layer. We show how both electrodes influence the junction spectra in the measured temperature range and how to correct this. Thus, we are able to interpret the pure junction spectra within known models.

This work was partially supported by DFG under project no. HA5934/3-1 and SE664/15-1, the EU under project no. FP7-283141 (IRON-SEA), the Deutscher Akademischer Austauschdienst, and the Landesgraduiertenförderung Thüringen.

TT 12.43 Mon 15:00 Poster D

Isoelectronic substitution of As with Sb in $BaFe_2As_2$ — •Daniel Schmidt and Hans F. Braun — Experimentalphysik V, Universität Bayreuth, D-95440 Bayreuth, Germany

The study of iron based superconductors has lead to the 122 iron pnictide compounds, that allow to investigate the interdependency of chemical doping and physical properties. Hole doping in $BaFe_2As_2$ was successfully achieved and transition temperatures of 38 K were obtained. Other doping procedures are possible, like the electron doping on the iron site and the isoelectronic substitution on the arsenic site. In our work we studied such an isoelectronic substitution of arsenic with the isovalent element Sb which has a larger ionic radius than arsenic. This way we induce chemical pressure in the compound. We tested the substitution level with X-ray powder diffraction measurements. The results of further measurements will be communicated.

TT 12.44 Mon 15:00 Poster D

Crystal growth of various ruthenates — •Stefan Kunkemöller[1], Agung Nugroho[2], and Markus Braden[1] — [1]II. Physikalisches Institut, Universität zu Köln — [2]Institut Teknologi Bandung

Ruthenates of the Ruddlesdon-Popper series exhibit a variety of interesting phenomena ranging from unconventional superconductivity to orbitally polarized Mott insulators. Unfortunately the crystal growth of most of these ruthenates is extremely difficult partially due to the high evaporation of ruthenium; this strongly limits the research on these fascinating materials. We have started to grow single crystals of layered and perovskite ruthenates by the travelling floating-zone method using a Canon SC1-MDH mirror furnace. For the layered $Ca_{2-x}Sr_xRuO_4$ series we focused first on the range of concentration where recent My-SR experiments reveal spin-density wave ordering to occur at relatively high temperature and with a sizeable ordered moment. Good quality crystals of $Ca_{1.5}Sr_{0.5}RuO_4$ can be obtained, when an excess of 15 percent of ruthenium is added to the initial preparation of the rod and when a high growth speed up to 40mm/h is used. Even slight modifications of the growing conditions result in large amounts of $(Sr/Ca)RuO_3$ and $(Sr/Ca)_3Ru_2O_7$ intergrowth phases. First attempts to grow perovskite and double-layered ruthenates will be discussed as well.

TT 12.45 Mon 15:00 Poster D

Superconductivity in Ge and Si via Ga-ion implantation — •Richard Skrotzki[1,2], Thomas Herrmannsdörfer[1], Rico Schönemann[1], Viton Heera[1], Jan Fiedler[1], Erik Kampert[1], Frederik Wolff-Fabris[1], Peter Philipp[1], Lothar Bischoff[1], Matthias Voelskow[1], Arndt Mücklich[1], Bernd Schmidt[1], Wolfgang Skorupa[1], Manfred Helm[1], and Joachim Wosnitza[1] — [1]Dresden High Magnetic Field Laboratory (HLD) and Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf (HZDR), P.O. Box 51 01 19, D-01314 Dresden, Germany — [2]Department of Chemistry and Food Chemistry, TU Dresden, 01062 Dresden, Germany

We present current progress of a unique study featuring the origin and use of superconductivity in highly Ga-doped group-IV semiconductors. Thin films have been prepared via ion implantation and subsequent short-term annealing. Germanium offers a high solubility for Ga acceptors (up to 1 at.%). Thus, superconductivity below about 0.5 K has been devoted previously solely to doping. However, recent atom-probe tomography reveals Ga nano-accumulations rendering the possibility of superconductivity in a proximity coupled network. In silicon, we have investigated a 10 nm thin amorphous Ga precipitation layer (T_c = 7 K) that is close to the superconductor to insulator transition. We present high magnetic field measurements up to 40 Tesla and evaluate the critical-field phase diagram. First proof for phase coherence has been detected via magneto-resistance oscillations in lithographically tailored structures. This opens the door for future device fabrication.

TT 12.46 Mon 15:00 Poster D

Proximity effect induced superconductivity in Cu- nanowires — •Maksym Kompaniiets[1], Fabrizio Porrati[1], Cornelia Neetzel[2], Wolfgang Ensinger[2], and Michael Huth[1] — [1]Physikalisches Institut, Goethe Universität, Frankfurt a. M — [2]Fachbereich Materialwissenschaften, TU Darmstadt, Darmstadt

Proximity effect induced superconductivity occurs at the interface of a normal metal and a superconductor when Copper pairs leak into the metal. Depending on the microstructure of the normal metal, anomalies just above the temperature of the superconducting phase transition can be observed in the temperature-dependent resistivity. We have studied proximity induced superconductivity in Cu-nanowires in contact with an amorphous superconductor (W-C-Ga-O) prepared by focused ion beam induced deposition (FIBID) employing the precursor $W(CO)_6$; contacts to the Cu-nanowires were made by using FIBID of $Pt-C$ leads with the precursor $MeCpPt(Me)_3$ in a dual-beam scanning electron/ion microscope. The nanowires have been prepared by electrochemical deposition in etched heavy-ion-track polycarbonate templates with diameters of 250 to 300 nm and lengths of 30 to 60 μm.

TT 12.47 Mon 15:00 Poster D

Superconductivity in Thin La Films — •Lihui Zhou, Peter Löptien, Alexander Khajetoorians, Jens Wiebe, and Roland Wiesendanger — Institute of Applied Physics, University of Hamburg, Hamburg, Germany

The issue of how thin superconducting films can get before they lose their superconductivity is of relevance for the fundamental understanding of quantum confined superconductors and for their possible technological applications in nanodevices [1,2]. Here, La islands with different thicknesses in the range of the superconducting coherence length have been grown on the W(110) surface under ultra-high vacuum conditions. Low-temperature scanning tunnelling spectroscopy using non-

superconducting and superconducting tips has been applied to determine the superconducting properties, i.e. the energy gap [3] and the lifetime broadening [4] of the quasiparticles. It is found that these parameters decrease linearly with the inverse island thickness, similar to recent experiments with Pb nano-islands on Si(111) [1,2], and in agreement with the theoretical calculation including a surface-energy term in the Ginzburg-Landau free-energy of a superconductor [5].

[1] C. Brun et al., Phys. Rev. Lett. 102, 207002 (2009)
[2] M. M. Özer et al., Nature Phys. 2, 173 (2006)
[3] I. Giaever, K. Megerle, Phys. Rev. 122, 1101 (1961)
[4] R. C. Dynes et al., Phys. Rev. Lett. 41, 1509 (1978)
[5] J. Simonin, Phys. Rev. B 33, 7830 (1986)

TT 12.48 Mon 15:00 Poster D

Direct measurement of the magnetic anisotropy of thin sputtered MgB_2 films — •Savio Fabretti, Inga-Mareen Imort, and Andy Thomas — Universität Bielefeld, Deutschland

The simple hexagonal crystal structure and large London penetration depth make Magnesium-diboride an excellent candidate for spin polarization measurements using the Meservey-Tedrow method. In a step towards these measurements, we investigated the magnetic anisotropy of thin MgB_2 films sputtered onto cubic (001)MgO and R-cut sapphire substrates. We present the high field cooling experiments with an applied magnetic field perpendicular and parallel to the film plane for those samples. These measurements were done in the high field laboratory in Nijmwegen due to the required high upper critical field for thin sputtered films of up to 30 T [1]. Our measurements show an upper critical field of 38.31 T with field parallel to the film plane and 27.7 T with a field perpendicular to the film plane for the samples with 120 nm MgB_2. A linear fit shows a good approximation with the data points, although the parallel magnetic field could not destroy the superconductivity. We achieved a magnetic anisotropy ratio of 1.38. Literature values show an anisotropy ratio between 1.25 and 2 for thin films, which was fit with the Ginzburg Landau theory [2]. Therefore our results agrees with the previously estimated anisotropy ratio for thin MgB_2 films, where magnetic fields of up to 7 T were used [3].

[1] M.H. Jung et al. Chem. Phys. Lett. 343 (2001) 447
[2] C. Buzea and T. Yamashita, Sci. Technol. 14 (2001) R115
[3] H. Shimakage et al., IEEE Trans. On Appl. Supercond. 15 No2 (2005)

TT 12.49 Mon 15:00 Poster D

Morphology of superconducting FeSe thin films grown by MBE and RF-sputtering — •Alexander Kronenberg[1], Eike Venzmer[1], Sebastian ten Haaf[1], Janek Maletz[1,2], and Martin Jourdan[1] — [1]Institut für Physik, Johannes Gutenberg Universität Mainz, Germany — [2]Leibniz-Institut für Festkörper- und Werkstoffforschung, Dresden, Germany

Tunneling spectroscopy on planar junctions is the most direct approach for the investigation of superconducting coupling mechanisms [1]. However, it requires smooth interfaces at the tunneling barrier. The morphology of superconducting thin films of FeSe grown by MBE and co-sputtering (RF) from an iron and a selenium target are compared. MBE deposited films show an extreme sensitivity to stoichiometry, deposition temperature and choice of substrate [2]. These films exhibit macroscopic crevices and a pronounced roughness, rendering the preparation of tunneling junctions impossible. However, sputter deposited epitaxial FeSe thin films clearly show a more favorable morphology. Optical microscopy, AFM and SEM demonstrate a smooth surface with segregations which are eliminated by proper choice of the deposition parameters.

[1] M. Jourdan, M. Huth and H. Adrian, Nature *398*, 47 (1999)
[2] M. Jourdan and S. ten Haaf, J Appl. Phys. *108*, 023913 (2010)

TT 12.50 Mon 15:00 Poster D

Competing instabilities in FeSe/$SrTiO_3$ superlattices — •Michael Fechner and Nicola Spaldin — ETH Zurich, Department for Material Theory,CH-8093 Zurich, Switzerland

Intercalating FeSe with atomic layers[1] has recently experimentally been shown to lead to an tremendous increase in the superconducting T_C. Due to that we discuss here results from first-principle calculations of FeSe/$SrTiO_3$ superlattices. In particular we discuss the competition between lattice instabilities in $SrTiO_3$ and the spin density wave (SDW) in FeSe. It turns out that depending on the interface termination a suppression or enhancement of the SDW is found. Interface doping and hybridization of Fe-oxygen and Ti-Se at the interface explain the results. Finally we discuss the impact of different thicknesses of the two components on the magnetic and electronic properties.

[1] M. Burrard-Luca et al., NatMat 11, 1 (2012).

TT 12.51 Mon 15:00 Poster D

Transport, magnetic and structural properties of YBCO/LCMO heterostructures grown on STO (110) substrates — •Luqman Mustafa[1], Soltan Soltan[1,2], Gennady Logvenov[1], Hanns-Ulrich Habermeier[1], and Bernhard Keimer[1] — [1]Max Planck Institute for Solid State Research, Heisenbergstraße 1, D-70569 Stuttgart, Germany — [2]Faculty of science, Helwan University, 11792-Helwan, Cairo, Egypt

YBCO/LCMO bi- and multilayers were grown on STO (110) substrates by Pulsed Laser Deposition (PLD) technique with the goal to study the interface of an oxide ferromagnet and a cuprate superconductor where the CuO2 planes are perpendicular to the film plane. The structure was investigated by X-ray diffractometry, transport and magnetic properties were studied by conventional four-point-probe and SQUID techniques respectively. Depending on the preparation conditions the single layer YBCO as well as bi-layers can be grown in the (110), (103)/(-103), as well as mixed orientations. Large anisotropy of electrical conductivity in these films was observed in case of (110)-oriented YBCO layer and less pronounced anisotropy in case of (103)-oriented one. We present a detailed analysis of the anisotropy of the magnetization of such bi- and multilayers emphasizing its relation to the orientation of the YBCO film.

TT 12.52 Mon 15:00 Poster D

B-T-phase diagram and Fulde-Ferrell-Larkin-Ovchinnikov State in an Organic Superconductor — •R. Beyer[1], J. Wosnitza[1], J. A. Schlueter[2], S. Jahns[3], and G. Zwicknagl[3] — [1]Hochfeld-Magnetlabor Dresden (HLD), Helmholtz-Zentrum Dresden-Rossendorf, D-01314 Dresden, Germany — [2]Materials Science Division, Argonne National Laboratory, Argonne, IL 60439, USA — [3]Institut für Mathematische Physik, TU Braunschweig, Mendelssohnstr. 3, 38106 Braunschweig, Germany

The low-temperature B-T- phase diagram of the layered organic superconductor κ-$(ET)_2$ $SF_5CH_2CF_2SO_3$, where ET is bisethylenedithiotetrathiafulvalene, has been studied. The highly precise specific heat measurements show strong variation of the superconducting transition with the orientation of the applied magnetic field. For field directions parallel to the superconducting planes the upper critical field is Pauli-limited exceeding the Chandrasekhar-Clogston limit at low temperatures. The superconducting transition is studied theoretically using realistic Fermi surfaces. Our results suggest that the phase, which separates the homogeneous superconducting state from the normal state is a realization of a Fulde-Ferrell-Larkin-Ovchinnikov state.

TT 12.53 Mon 15:00 Poster D

Paramagnetic Cooper pair breaking effect in α-(BEDT-TTF)$_2$KHg(SCN)$_4$ — •Michael Kunz[1], Sebastian Jakob[1], Werner Biberacher[1], Karl Neumaier[1], Harald Müller[2], and Mark V. Kartsovnik[1] — [1]Walther-Meißner-Institut, Garching, Germany — [2]European Synchrotron Radiation Facility, Grenoble, France

The organic charge transfer salt α-$(BEDT\text{-}TTF)_2KHg(SCN)_4$ is a quasi-two-dimensional metal consisting of conducting and insulating layers. At pressures above 2.5 kbar this compound features a low T_c ($\sim$ 0.1 K) superconducting state with an unprecedentedly high anisotropy of the upper critical field depending on whether the magnetic field is oriented parallel or perpendicular to the conducting planes. This is due to a strong suppression of the superconducting shielding currents in the direction perpendicular to the layers. For an exact parallel field orientation the shielding currents become so weak that their effect is replaced by the Pauli paramagnetic effect as the main contribution to the Cooper pair breaking. Clear manifestations of the paramagnetic pair breaking can be seen in the temperature dependence as well as in the angular dependence of the critical field near parallel orientation. At the exact parallel field orientation, the theoretical Chandrasekhar-Clogston paramagnetic limit is exceeded by a factor of 1.3, most likely due to a strong electron-phonon coupling. From the analysis of the temperature dependence of the parallel critical field the Maki parameter can be determined.

TT 12.54 Mon 15:00 Poster D

de Haas-van Alphen investigations on the filled skutterudite $LaRu_4As_{12}$ superconductor — •Johannes Klotz[1], Kathrin

Götze[1,3], Tomasz Cichorek[2], Zygmunt Henkie[2], and Joachim Wosnitza[1] — [1]Hochfeld-Magnetlabor Dresden, Helmholtz-Zentrum Dresden-Rossendorf, Germany — [2]Institute of Low Temperature and Structure Research, Polish Academy of Sciences, Wrocław, Poland — [3]TU Dresden, Institut für Festkörperphysik, Germany

$LaRu_4As_{12}$ belongs to the filled skutterudite compounds which show a wide variation in physical properties such as metal-insulator transition, unconventional superconductivity, and quadrupolar or magnetic ordering [1]. It shows enhanced superconducting properties as compared to other skutterudite superconductors (T_c = 10.45 K and $H_{c2} \approx$ 10.2 T) and, more importantly, multiple superconducting gaps have been inferred from the magnetic-field dependence of the specific heat and a positive curvature of $H_{c2}(T)$ close to T_c making $LaRu_4As_{12}$ a rare example of a cubic superconductor displaying multiband effects [2]. We investigated the angular dependence of the dHvA effect using the capacitive torque method at temperatures down to 30 mK and in fields up to 18 T. Effective masses for different bands were determined expecting rather heavy masses due to a high electronic specific-heat coefficient $\gamma = 59$ mJ/mol K^2. In combination with band-structure calculations our results will provide a detailed picture of the Fermi surface and the electronic correlations.

[1] M.B. Maple, E.D. Bauer, *et al.*, Physica B **328** (2003)
[2] L. Bochenek, R. Wawryk, *et al.*, Phys. Rev B **86**, 6 (2012)

TT 12.55 Mon 15:00 Poster D

High-Field Magnetotransport in the Electron-Doped Cuprate Superconductor $Nd_{2-x}Ce_xCuO_4$ — •Toni Helm[1], M .V. Kartsovnik[1], E. Kampert[2], C. Putzke[2], W. Biberacher[1], P. D. Grigoriev[3], S. Baddoux[4], C. Proust[4], I. Sheikin[4], A. Kiswandhi[5], J. S. Brooks[5], E. S. Choi[5], J. Wosnitza[2], A. Erb[1], and R. Gross[1] — [1]Walther-Meissner-Institute, Garching, Germany — [2]High Magnetic Field Laboratory, Dresden, Germany — [3]L. D. Landau Institute for Theoretical Physics, Chernogolovka, Russia — [4]Laboratoire National des Champs Magnétiques Intenses CNRS, Toulouse-Grenoble, France — [5]National High Magnetic Field Laboratory,Tallahassee, USA

The current status of the high-field magnetotransport studies of the Fermi surface in the electron-doped cuprate superconductor $Nd_{2-x}Ce_xCuO_4$ will be presented. Both the magnetic quantum oscillations and semiclassical angle-dependent magnetoresistance give evidence of a weak $(\pi/a, \pi/a)$-superlattice potential existing at the overdoped regime, $0.15 \leq x \leq 0.17$. The relevant energy gap is very small, $\sim 10 - 2\,\mathrm{eV}$; it is gradually suppressed at increasing the doping level, extrapolating to zero right at the edge of the superconducting dome, $x = 0.175$. On the other hand, decreasing the doping below the optimal level leads to dramatic changes in the behavior of magnetotransport including the Shubnikov-de Haas oscillations, magnetoresistance and Hall effect. Our data suggest a Fermi surface transformation leading to a collapse of the classical closed cyclotron orbits responsible for the conventional galvanomagnetic effects.

TT 12.56 Mon 15:00 Poster D

Charge-Density-Wave State in the Ladder Compound $Sr_{10}Ca_4Cu_{24}O_{41}$ under High Pressure — •Armin Huber[1], Rüdiger Klingeler[2], Markus Hücker[3], Bernd Büchner[4], and Christine Kuntscher[1] — [1]Experimentalphysik II, Universität Augsburg, D-86159 Augsburg, Germany — [2]Kirchhoff-Institute for Physics, D-69120 Heidelberg, Germany — [3]Brookhaven National Laboratory, Upton, NY 11973-5000, USA — [4]Leibniz-Institut für Festkörper-und Werkstoffforschung Dresden, PF 27 01 16, 01171 Dresden, Germany

Besides the occurrence of superconductivity under pressure in the two-leg ladder compound $Sr_{10}Ca_4Cu_{24}O_{41}$, the existence of a competing charge density wave (CDW) ground state is a highly interesting phenomenon in this material. An earlier study demonstrated how the CDW is suppressed by increasing the calcium content, which was attributed to increased dimensionality and disorder [1].

However, no information is currently available about the evolution of the CDW under pressure. Therefore, we studied the polarization-dependent optical response of $Sr_{10}Ca_4Cu_{24}O_{41}$ in the mid-infrared frequency range as a function of temperature and pressure. Based on these results, we can extend the phase diagram and discuss more quantitatively how holes are transferred from the chains to the ladders under the application of pressure.

Supported by the DFG.

[1] T.Vuletić et al., Phys. Rev. Lett. 90, 257002 (2003)

TT 12.57 Mon 15:00 Poster D

Phonon line shapes in the vortex state of the phonon-mediated superconductor YNi_2B_2C — •Frank Weber[1], Lothar Pintschovius[1], Klaudia Hradil[2], and Daniel Petitgrand[3] — [1]Institut für Festkörperphysik, Karlsruher Institut für Technologie, Karlsruhe, Germany — [2]Institut für Physikalische Chemie, Universität Göttingen, Außenstelle FRM-II, Garching, Germany — [3]Laboratoire Léon Brillouin (CEA-CNRS), CEA-Saclay, Gif-sur-Yvette, France

We present an inelastic neutron-scattering study of phonon line shapes in the vortex state of the type II superconductor YNi_2B_2C. In a previous study [1] we showed that certain phonons exhibit a clear signature of the superconducting gap 2Δ on entering the superconducting state. Our interest was to find out whether or not the line shape of such phonons reflects the inhomogeneous nature of the vortex state induced by a magnetic field smaller than the upper critical field $\mathbf{B}_{c2}$.We found that this is indeed the case because the observed phonon line shapes can be well described by a model considering the phonon as a local probe of the spatial variation of the superconducting gap.

[1] F. Weber, A. Kreyssig, L. Pintschovius, R. Heid, W. Reichardt, D. Reznik, O. Stockert, and K. Hradil, Phys. Rev. Lett. 101, 237002 (2008)