experimentelle und angewandte

The antagonism of superconductivity and magnetism is investigated by fabricating Nb based Josephson Junction with lateral weak links consisting of Nb-$Pd_{0.95}Fe_{0.05}$ bi-layers with lengths between 200 and 500 nm. The critical current (I_C) of the Nb-$Pd_{0.95}Fe_{0.05}$ bi-layer is found to be significantly reduced by the weak ferromagnetism in the $Pd_{0.95}eFe_{0.05}$ alloy. We have studied the temperature and magnetic field (B) dependencies of the critical current. In magnetic field an irregular supercurrent interference pattern $I_C(B)$ is observed. The shape of the $I_C(B)$ oscillations is similar to that observed for grain boundary junctions between cuprate superconductors. We also investigate the dependence of $I_C(B)$ oscillations on the orientation of the magnetic field.

TT 15.36 Tue 14:00 Poster B

Multi-terminal Josephson Junctions with Ferromagnetic Elements — •Martin Leib and Wolfgang Belzig — Fachbereich Physik, Universität Konstanz, D-78457 Konstanz

The interplay between magnetism and superconductivity in heterostructures has attracted considerable interest since the discovery of the 0-π transition in superconductor-ferromagnet (SF) contacts. Here we investigate the supercurrent in systems of multiple tunnel junctions in the framework of the quantum circuit theory. The considered network consists of two superconducting and two ferromagnetic reservoirs with non-collinear magnetization direction connected by tunnel contacts to a normal metal. We find and interesting interplay between the superconducting phase difference and the relative magnetization angle, which manifests itself in the current phase relation and the critical current.

TT 15.37 Tue 14:00 Poster B

SQUID readout of the magnetic flux states of fractional Josephson vortices. — •Andreas Dewes, Dieter Kölle, Reinhold Kleiner, and Edward Goldobin — Physikalisches Institut-Experimentalphysik II and Center for Collective Quantum Phenomena, Universität Tübingen

We present an experimental study of a direct SQUID readout of the various states of a fractional vortex molecule in a long 0-κ-0 or 0-κ-2κ Josephson junction[1]. The fractional vortices appear at the discontinuities of the Josephson phase that are created by using tiny pairs of current injectors[2,3]. The magnetic field of each vortex is coupled to an integrated DC SQUID placed in front of it. In experiment, we measure the magnetic flux Φ in the SQUID loop as a function of the bias current of the junction I, of the injector current $I_{\rm inj}$ and of the magnetic field H. By changing the bias current of the junction or by modifying the discontinuity $\kappa \propto I_{\rm inj}$ we can induce and observe transitions between all four states of the fractional vortex molecule ($\uparrow\uparrow$, $\downarrow\uparrow$, $\uparrow\downarrow$ and $\downarrow\downarrow$). The readout system is intended to be part of a prospective fractional vortex qubit[4].

[1] E. Goldobin et. al., *Phys. Rev. B* **70**, 174519 (2004).
[2] B. A. Malomed et. al., *Phys. Rev. B* **69**, 064502 (2004).
[3] E. Goldobin et. al., *Phys. Rev. Lett.* **92**, 057005 (2004).
[4] E. Golodbin et. al., *Phys. Rev. B* **72**, 054527 (2005).

TT 15.38 Tue 14:00 Poster B

Spectroscopy of the eigenfrequencies of a fractional Josephson vortex molecule — •Uta Kienzle[1], Tobias Gaber[1], Kai Buckenmaier[1], Konstantin Ilin[2], Michael Siegel[2], Dieter Koelle[1], Reinhold Kleiner[1], and Edward Goldobin[1] — [1]Physikalisches Institut - Experimentalphysik II and Center for Collective Quantum Phenomena, Universität Tübingen — [2]Institut für Mikro- und Nanoelektronische Systeme, Universität Karlsruhe (TH)

Using a pair of tiny current injectors one can create an arbitrary κ discontinuity of the phase in a long Josephson junction (LJJ) [1]. To compensate this discontinuity a κ vortex spontaneously appears [2]. This vortex carries an arbitrary fraction $\propto\kappa$ of the magnetic flux quantum Φ_0 and is a generalization of a semifluxon observed in 0-π LJJs [3]. Such a vortex is pinned at the discontinuity point, but in an underdamped system it is able to oscillate around its equilibrium position with an eigenfrequency [4,5]. In annular LJJs with two injector pairs two coupled κ vortices, forming a molecule, can be studied.

The dependence of the eigenfrequency on temperature and κ of one and two coupled vortices was measured in the range from 300 mK up to 4.2 K. We discuss the results and compare them with simulations based on the perturbed sine-Gordon equation.

[1] E. Goldobin *et al.*, Phys. Rev. Lett. **92**, 57005 (2004)
[2] E. Goldobin *et al.*, Phys. Rev. B **70**, 174519 (2004)
[3] H. Hilgenkamp *et al.*, Nature **422**, 50 (2003)
[4] E. Goldobin *et al.*, Phys. Rev. B **71**, 104518 (2005)
[5] K. Buckenmaier *et al.*, Phys. Rev. Lett. **98**, 117006 (2007)

TT 15.39 Tue 14:00 Poster B

Two dimensional planar superconducting quantum interference device gradiometer on a $SrTiO_3$ bicrystal — •Uwe Schinkel, Christoph Becker, Veit Grosse, Alexander Steppke, Frank Schmidl, and Paul Seidel — Institut für Festkörperphysik, Friedrich Schiller Universität Jena, Germany

Superconducting sensors are state of the art for the measurement of small magnetic signals. Gradiometers with DC SQUID sensors can be used in magnetically unshielded areas, due to the high surpression of homogeneous magnetic fields. 2nd order gradiometers achieve an even higher reduction of external noise.

We show a new gradiometer layout based on YBCO thin films to detect the second order field gradient. In a planar configuration four galvanically coupled antenna structures are read out by a symmetric DC SQUID with four Josephson junctions on $SrTiO_3$ bicrystals. Simulations, the preparation process and first electric measurements are presented.

TT 15.40 Tue 14:00 Poster B

Planar flip-chip HTSC DC-SQUID gradiometers for non-destructive evaluations — •Christoph Becker[1], Alexander Steppke[1], Uwe Schinkel[1], Markus Buettner[1], Veit Grosse[1], Hendrik Schneidewind[2], Frank Schmidl[1], and Paul Seidel[1] — [1]Friedrich-Schiller-Universität Jena, Germany — [2]Institut für Photonische Technologien e.V., Jena, Germany

For the detection of small magnetic signals, for example in applications like non-destructive evaluation DC-SQUID gradiometers are successfully used today. The low noise level of our sensors and the possibility of working in unshielded environments cannot be achieved with convential methods. The sensors made out of high-temperature superconducting thin film gradiometers are inductively coupled to a flux-transformer in a flip-chip configuration.

The field gradient resolution of the complete system is below $1\,\mathrm{pT}/(\sqrt{\mathrm{Hz}}\,\mathrm{cm})$. In our investigations we focused on the spatial resolution of the sensors. Different approaches to characterize the resolution and methods to improve the signal to noise ratio for small magnetic sources are shown.

TT 15.41 Tue 14:00 Poster B

Different transport mechanisms across semiconductor junctions — •Barbara Sandow[1], Dirk Brossell[1], and Walter Schirmacher[2] — [1]Institut für Experimentalphysik, Freie Universität Berlin, Germany — [2]Physik-Department E13, Technische Universität München, Germany

We used break-junction tunnelling spectroscopy to investigate the Coulomb correlation in n-type Germanium. The Charge transport across break-junctions of n-type Germanium has been investigated. The low-T spectra of our Ge break junctions vary systematically with contact size. However, it is not always clear what kind of processes dominate the spectra of those contacts. We show how to identify and separate the different transport mechanisms across the junctions, necessary to derive the Density of states.

TT 15.42 Tue 14:00 Poster B

Fine structure in the tunneling characteristic of MgB_2 thin films — •Rudolf Schneider[1], Jochen Geerk[1], Alexander Zaitsev[1], and Hilbert von Löhneysen[1,2] — [1]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, 76021 Karlsruhe — [2]Physikalisches Institut, Universität Karlsruhe, 76128 Karlsruhe

We report on a progress in the *in situ* preparation of superconducting MgB_2 thin films by thermal evaporation of Mg combined with B sputtering. By sputtering the boron from a red-hot sintered target we were able to increase the substrate temperature up to 550°C. The film properties, like T_c and the residual resistivity, significantly improved compared to films deposited at lower substrate temperatures. In the negative second derivative of the current-voltage characteristic measured on sandwich-type crossed-strip tunnel junctions on MgB_2 films with a T_c of 35 K, theoretically predicted fine structures could be resolved which were missing in our former tunnelling experiments using films with a lower T_c of 32 K. Better crystalline order within the MgB_2 grains is evidently the key to the details of the electron-phonon

coupling.

TT 15.43 Tue 14:00 Poster B

Effect of a dc magnetic field on the microwave losses in MgB_2 thin films — •Roland Hott[1], Alexander G. Zaitsev[1], Rudolf Schneider[1], Thorsten Schwarz[2], and Jochen Geerk[1] — [1]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, P.O. Box 3640, D-76021 Karlsruhe, Germany — [2]Forschungszentrum Karlsruhe, Institut für Synchrotronstrahlung, P.O. Box 3640, D-76021 Karlsruhe, Germany

The microwave surface impedance ($Z_s = R_s + iX_s$) of in situ MgB_2 thin films was measured as a function of temperature and parallel dc magnetic field at several frequencies between 5.7 and 18.5 GHz using a dielectric resonator technique. The results are consistent with the expectations for a classical type-II superconductor and, consequently, quite different from those of the high-T_c cuprates. The films cooled in zero field revealed a clear indication of the lower critical field B_{c1}, with a small hysteresis around $B \leq B_{c1}$. In higher fields ($B > B_{c1}$), the losses followed the Coffey-Clem and Brandt model, including the frequency dependences, whereas high-T_c Y-Ba-Cu-O films did not show a reasonable agreement with this model. Both the relatively high values of $\Delta X_s/\Delta R_s$ ratio and their frequency dependence indicate a weak effect of flux creep on the measured microwave loss in MgB_2 films. The temperature dependence of $\Delta X_s/\Delta R_s$ ratio can be described by a microscopic pinning model for BCS superconductors.

TT 15.44 Tue 14:00 Poster B

Static and time-resolved vortex dynamics in a-$Nb_{0.7}Ge_{0.3}$ — •Florian Otto[1], Martin Frisch[1], Ante Bilušić[1], Dinko Babić[2], Christoph Sürgers[3], and Christoph Strunk[1] — [1]Inst. for Exp. and Appl. Physics, Univ. Regensburg, Germany — [2]Dept. Physics, Univ. Zagreb, Croatia — [3]Phys. Inst. and DFG Center for Funct. Nanostr. (CFN), Univ. Karlsruhe, Germany

We investigate the motion of vortices in amorphous $Nb_{0.7}Ge_{0.3}$. Because of the very low pinning in this high-κ type-II superconductor, we are able to measure local and non-local transport in the flux-flow regime over large parts of the B-T-phase diagram [1]. Interestingly, there is a finite non-local response close to T_c, even when the applied magnetic field is zero. This points towards the presence of spontaneously formed vortex-antivortex pairs above the Berezinskii-Kosterlitz-Thouless transition. In addition, we report first non-local transport measurements in the time domain, using a boxcar averaging technique.

[1] A.Helzel et al., Phys. Rev. B **74**, 220510 (R) (2006)

TT 15.45 Tue 14:00 Poster B

Unexpected temperature-dependence of the critical current in NbN-microbridges — •Andreas Engel[1], Holger Bartolf[1], Luis Gomez[1], Andreas Schilling[1], Konstantin Il'in[2], Michael Siegel[2], Alexei Semenov[3], and Heinz-Wilhelm Hübers[3] — [1]Physics Institute, University of Zürich, Winterthurerstr. 190, CH-8057 Zürich — [2]Institute of Micro- and Nano-Electronic Systems, University of Karlsruhe, Hertzstr. 16, 76187 Karlsruhe — [3]DLR e.V. Institute of Planetary Research, Rutherfordstr. 2, 12489 Berlin

Superconducting micro- and nanostructures made from NbN ultra-thin films are key elements of THz hot-electron bolometer mixers and single-photon detectors for the visible and near-infrared. Their detection mechanisms require operation with a biasing current close to but below the device's critical current I_c at temperatures well below their critical temperature. We studied the temperature-dependence $I_c(T)$ of up to 10 nm thick NbN bridges with widths between 100 nm and 10 μm. The temperature-dependence of the critical-current density j_c of sub-micrometer wide bridges is well described by the de-pairing j_c. They remain free of magnetic vortices due to a geometrically enhanced Bean-Livingston barrier. Micrometer-wide bridges show a cross-over from de-pairing to de-pinning j_c with decreasing temperature. Moreover, at low temperatures, when I_c is determined by the de-pinning of magnetic vortices due to the self-field of the applied current or small external magnetic fields, $I_c(T)$ may exhibit non-monotonic behavior, *i.e.* reduced I_c at lower temperature. We present experimental data of these unexpected features and discuss their possible reasons.

TT 15.46 Tue 14:00 Poster B

Flux dynamics in HT-superconductor thin films influenced by a surface acoustic wave — •Munise Rakel[1], Arno Wirsig[1], Carsten Hucho[1], and Joachim Albrecht[2] — [1]Paul-Drude-Institut, 10117 Berlin, Germany — [2]Max-Planck-Institut für Metallforschung, 70569 Stuttgart, Germany

We report on magneto-optic investigations of the influence of a traveling strain wave on the magnetic flux density distribution in a type-II superconductor. The investigations are performed on a thin film of YBCO on a piezoelectric substrate using a custom-made magneto-optical microscope. The strain wave is generated by interdigital transducers on the piezoelectric substrate. An external magnetic field applied perpendicular to the surface enters the polycrystalline superconductor depending on the pinning properties. Strain-wave induced pinning-changes or SAW-induced depinning is reported to result in changes in the flux dynamics. We analyze magneto-optic greyscale images of films with dynamically altered pin-state to yield information on the influence of the combined dynamic strain- and electric field on the pinning behavior of the superconducting film.

TT 15.47 Tue 14:00 Poster B

Reconstruction of the electric field distributions for flux dynamics studies in superconducting thin films — •Carolina Romero-Salazar[1], Omar Augusto-Flores[2], and Christian Jooss[1] — [1]Institut fuer Materialphysik, Friedrich Hund Platz 1, 37077 Goettingen, Germany — [2]Instituto de Fisica, Universidad Autonoma de Puebla, Apdo. Post. J-48, Puebla, Mexico

It is well known that in type-II superconductors there are electric fields due to vortex motion. The space-resolved study allows for insights into the mechanism of vortex dynamics and the occurrence of local losses. This is an important and challenging problem for the development of high-current carrying applications with low electromagnetic losses. The electric field in high- T_c superconducting films is reconstructed employing magneto-optical imaging of the magnetic induction $B_z(r)$ distributions. We developed a consistent method to calculate both dynamic and static contributions of the electric field, for a thin film in the so called perpendicular geometry. We investigate the contrasts between our technique, which employs magnetic relaxation measurements, and the theoretical scheme which requires an effective material law, $E = \rho J$, obtained from current transport experiments. Understanding the vortex dynamics in homogeneous superconducting films, provides a necessary background to study materials with complicate structures as patterned holes or inhomogeneous pinning.

TT 15.48 Tue 14:00 Poster B

Nernst effect of Ni-doped $NdBa_2Cu_3O_{7-\delta}$ — •Niko Johannsen[1], Thomas Wolf[2], Alexander V. Sologubenko[1], Thomas Lorenz[1], Axel Freimuth[1], and John A. Mydosh[1] — [1]II. Physikalisches Institut, University of Cologne, Germany — [2]Forschungszentrum Karlsruhe, Germany

The mechanism of high-temperature superconductivity is still unsolved. Possible relations to other phenomena such as the pseudogap may play a key role towards an understanding of this mechanism. Using the Nernst effect, we are able to detect vortex-like excitations very sensitively. In $NdBa_2\{Cu_{1-y}Ni_y\}_3O_{7-\delta}$, magnetic Ni-impurities suppress T_c and at the same time enhance the pseudogap. So, this is an ideal system to study possible relations between the pseudogap and superconductivity via the Nernst effect. We present measurements on a series of optimally doped (O_7) and two underdoped ($O_{6.8}$, $O_{6.9}$) samples with Ni contents ranging from y=0 to 0.12. For the optimally doped samples, the onset temperature of the anomalous Nernst signal (T^ν) decreases with increasing Ni content as does T_c. The underdoped ($O_{6.8}$) samples show a slightly different behavior. T^ν is not affected by an increase of the Ni content. The slope of T^ν of the intermediate doping level ($O_{6.9}$) lies between the aforementioned two. None of the detected anomalous vortex Nernst signals shows a relation to the enhanced pseudogap in this system.

TT 15.49 Tue 14:00 Poster B

Proximity Effect in Nb/Au and NbN/Au bi-layers for THz Antenna Structures of HEB Mixers — •Axel Stockhausen[1], Konstantin Il'in[1], Michael Siegel[1], Alexei Semenov[2], Heinz-Wilhelm Hübers[2], Reinhard Schneider[3], and Dagmar Gerthsen[3] — [1]IMS, University of Karlsruhe, Karlsruhe, Germany — [2]DLR e.V. Institute of Planetary Research, Berlin, Germany — [3]LEM, University of Karlsruhe, Karlsruhe, Germany

Hot-electron Bolometer (HEB) mixers are high sensitive heterodyne detectors made from ultra-thin (< 5 nm) NbN film deposited on Si substrate. For proper operation of these devices in THz frequency range a superconducting detecting element is embedded into antenna