Section Low Temperature Physics
Fachverband Tiefe Temperaturen (TT)

Michael Siegel
Universität Karlsruhe
Institut für Mikro- und Nanoelektronische Systeme
Hertzstraße 16
76128 Karlsruhe
m.siegel@ims.uni-karlsruhe.de

Overview of Invited Talks and Sessions

(Lecture rooms H18, H19, and H20; Poster A)

Internal Symposia within TT

TT12 Symposium: "Coated HTS Conductors"

Organization: W. Goldacker (Forschungszentrum Karlsruhe)

TT 12.1	Tue	9:30–10:00	H20	**Improvement of the Critical Current Density in YBCO Coated Conductors** — •Bernhard Holzapfel
TT 12.2	Tue	10:00–10:15	H20	**A Reel to Reel MOCVD process for Coated Conductors** — •Oliver Stadel
TT 12.3	Tue	10:15–10:30	H20	**The potential of Roebel assembled coated conductor cables** — •Curt Schmidt
TT 12.4	Tue	10:45–11:00	H20	**Limitation of fault current in power grids using YBCO coated conductors** — •Wolfgang Schmidt
TT 12.5	Tue	11:00–11:15	H20	**Switching and Quench Propagation in Coated Conductors for Fault Current Limiters** — •Helmut Kinder
TT 12.6	Tue	11:15–11:30	H20	**Nexans Advances in all CSD Route for REBCO Coated Conductors** — •Mark Rikel
TT 12.7	Tue	11:30–11:45	H20	**Temperature series to study the biaxial texturing of $La_2Zr_2O_7$ buffer layers on nickel-tungsten substrates** — •Leopoldo Molina
TT 12.8	Tue	12:00–12:15	H20	**The pyrolysis of $YBa_2Cu_3O_{7-\delta}$ thin films produced by metal-organic deposition using trifluoroacetic acid-based precursors** — •Thomas Thersleff
TT 12.9	Tue	12:15–12:30	H20	**Artificial pinning centers in $YBa_2Cu_3O_{7-x}$ thin films created by nanoparticles from the gas phase** — •Maria Sparing
TT 12.10	Tue	12:30–12:45	H20	**Development of conductive buffer architectures based on IBAD-TiN** — •Ruben Hühne
TT 12.11	Tue	12:45–13:00	H20	**Improved pinning in $YBa_2Cu_3O_{7-x}$ based quasi-multilayers prepared by off-axis pulsed laser deposition** — •Elke Backen

TT13 Symposium: "Superconductivity and Magnetism in Lamellar Cobaltates"

Organization: I. Eremin (MPI for Physics of Complex Systems (Dresden) & TU Braunschweig), P. Lemmens (TU Braunschweig), C. T. Lin (MPI for Solid State Research (Stuttgart))

TT 13.1	Tue	14:00–14:30	H18	**Angle-resolved photoemission studies on Na_xCoO_2** — •Hong Ding
TT 13.2	Tue	14:30–15:00	H18	**Phase diagram and in-plane spin fluctuation in the novel superconducting system Na_xCoO_2 * y H_2O** — •Kazuyoshi Yoshimura
TT 13.3	Tue	15:00–15:25	H18	**Cooper-pair symmetry and spin correlations in the cobaltate superconductors Na_xCoO_2 * 1.3 H_2O** — •Guo-qing Zheng

TT 13.4	Tue	15:40–16:05	H18	**Magnetic phase separation in highly Na doped Na_xCoO_2 with x > 0.75.** — •Christian Bernhard
TT 13.5	Tue	16:05–16:30	H18	**Magnetic properties of spin-orbital polarons in lightly doped cobaltates** — •Maria Daghofer
TT 13.6	Tue	16:30–16:55	H18	**Magnetic ordering and excitations in Na_xCoO_2** — •Sibel Bayrakci
TT 13.7	Tue	17:10–17:35	H18	**Superconducting epitaxial thin films of $Na_xCoO_2 \cdot yD_2O$: A route to new experiments** — •Lambert Alff
TT 13.8	Tue	17:35–17:50	H18	**Electronic theory for itinerant in-plane magnetic fluctuations and many-body correlations in Na_xCoO_2** — •Maxim Korshunov

TT16 Symposium: "50 Years BCS Theory"

Organization: P. Wölfle & M. Siegel (Universität Karlsruhe)

TT 16.1	Tue	18:00–18:30	H20	**BCS theory of a neutral Fermi liquid: the superfluid phases of Helium 3** — •Peter Woelfle
TT 16.2	Tue	18:30–19:00	H20	**Unconventional BCS States in Heavy-Fermion Superconductors** — •Frank Steglich
TT 16.3	Tue	19:00–19:30	H20	**Hochtemperatur-Supraleitung: Ein Beispiel für die BCS-Idee?** — •Werner Hanke
TT 16.4	Tue	19:30–20:00	H20	**Strolling through and beyond the Fields of BCS** — •Jochen Mannhart

TT19 Symposium: "Terahertz Detectors"

Organization: H.-G. Meyer (IPHT Jena), H.-W. Hübers (DLR Berlin)

TT 19.1	Wed	14:00–14:40	H20	**Superconducting detectors and mixers for submillimeter astrophysics** — •Jonas Zmuidzinas
TT 19.2	Wed	14:40–15:20	H20	**Superconducting detectors for low-background far infrared space astronomy** — •Philip Mauskopf
TT 19.3	Wed	15:20–15:50	H20	**Terahertz detectors using hot-electrons in superconducting films** — •Alexei Semenov
TT 19.4	Wed	15:50–16:20	H20	**SIS and HEB Devices for THz Frequency Mixer Applications** — •Karl-Friedrich Schuster
TT 19.5	Wed	16:30–17:00	H20	**Terahertz Bolometer Arrays for APEX** — •Ernst Kreysa
TT 19.6	Wed	17:00–17:30	H20	**FIR Detectors for Herschel and SOFIA** — •Albrecht Poglitsch
TT 19.7	Wed	17:30–18:00	H20	**A superconducting Terahertz imager** — •Torsten May

TT24 Symposium: "Condensed Matter Phases in Ultracold Atoms"

Organization: W. Hofstetter (Universität Frankfurt)

TT 24.1	Thu	9:30–10:00	H20	**Probing interacting systems of cold atoms using interference experiments** — •Eugene Demler
TT 24.2	Thu	10:00–10:30	H20	**Criticality and correlations in cold atomic gases** — •Michael Köhl
TT 24.3	Thu	10:30–10:45	H20	**Bose gas in Flatland** — •Zoran Hadzibabic
TT 24.4	Thu	11:10–11:35	H20	**Simulations of ultra-cold atom gases on frustrated optical lattices** — •Stefan Wessel
TT 24.5	Thu	11:35–12:00	H20	**Multicolor Hubbard models with ultracold atoms** — •Carsten Honerkamp
TT 24.6	Thu	12:00–12:25	H20	**Fermionic Superfluidity with Imbalanced Spin Populations** — •Martin Zwierlein
TT 24.7	Thu	12:25–12:50	H20	**Vortex Matter in Optical Lattices** — •Michiel Snoek

TT27 Symposium: "Graphene" in Continuation of the HL Symposium HL35 (Thu 10:00-12:30 H1)

Organization: G. Cuniberti (Universität Regensburg)

TT 27.1	Thu	14:00–14:30	H20	**Graphene: New bridge between condensed matter physics and QED** — •Mikhail Katsnelson
TT 27.2	Thu	14:30–14:55	H20	**Magnetic confinement of massless Dirac fermions in graphene** — •W. Häusler
TT 27.4	Thu	15:20–15:50	H20	**Transport properties of mesoscopic graphene** — •Björn Trauzettel
TT 27.5	Thu	15:50–16:15	H20	**Scattering approach to disordered graphene** — •Mikhail Titov

Further Invited Talks

TT 3.1	Mon	9:30–10:00	H20	**Experimental investigation of superconducting flux qubits** — •Evgeni Ilichev
TT 5.1	Mon	14:00–14:30	H18	**Time-dependent density-functional theory: the framework, applications and recent developments** — •Lucia Reining
TT 5.7	Mon	16:00–16:30	H18	**Electronic Correlations in Electron-Transfer Systems** — •Ralf Bulla
TT 9.4	Mon	17:00–17:30	H20	**Crossed Andreev Reflection in Superconductor-Ferromagnet Hybrid Structures** — •Detlef Beckmann
TT 14.5	Tue	15:00–15:30	H19	**Topological phases in condensed matter** — •Roderich Moessner
TT 15.6	Tue	15:30–16:00	H20	**Fractional flux quanta in Josephson junctions** — •Edward Goldobin
TT 15.7	Tue	16:00–16:30	H20	**SQUID Technology for Geophysical Exploration** — •Hans-Georg Meyer

Joint Symposia With Other Sections

SYSS Symposium: "Spins in Semiconductors"

(arranged by the divisions HL, MA, O, TT)
Organization: G. Bayreuther & J. Fabian (Universität Regensburg)

SYSS 1.1	Mon	9:30–10:00	H1	**Generating and manipulating spins in semiconductors** — •David Awschalom
SYSS 1.2	Mon	10:00–10:20	H1	**Spin noise spectroscopy and spin dynamics in semiconductors** — •Michael Oestreich
SYSS 1.3	Mon	10:20–10:40	H1	**Spin-orbit interaction in Si quantum wells** — •Wolfgang Jantsch
SYSS 1.4	Mon	10:40–11:00	H1	**Driven coherent oscillations of a single electron spin in a quantum dot** — •Frank Koppens
SYSS 1.5	Mon	11:00–11:20	H1	**Electrical spin injection and detection in semiconductors** — •Paul Crowell
SYSS 1.6	Mon	11:20–11:40	H1	**A microscopic view of the magnetism in magnetic semiconductors** *(replaces the contribution by N. Samarth)* — •Michael Flatté
SYSS 1.7	Mon	11:40–12:00	H1	**Tailoring ferromagnetism in bulk semiconductors and quantum dots** — •Igor Zutic
SYSS 1.8	Mon	12:00–12:20	H1	**Tunnel Anisotropic Magneto Resistance - TAMR** — •Laurens Molenkamp
SYSS 1.9	Mon	12:20–12:40	H1	**Electric field controlled spintronic effects based on spin-orbit coupling** — •Tomas Jungwirth
SYSS 1.10	Mon	12:40–13:00	H1	**Zero-bias spin separation in semiconductor heterostructures** — •Sergey Ganichev

SYEN Symposium: "Entanglement"

(arranged by the divisions DY, HL, TT)
Organization: J. Siewert (Universität Catania(Italien))

SYEN 1.1	Thu	14:00–14:30	H1	**Probabilities (and more) from entanglement** — •Wojciech Zurek
SYEN 1.2	Thu	14:30–15:00	H1	**Entanglement and the Foundations of Statistical Mechanics** — •Sandu Popescu
SYEN 1.3	Thu	15:00–15:30	H1	**Universality and classical simulation of quantum computation** — •Hans Briegel

SYEN 1.4	Thu	15:30–16:00	H1	**Towards the convex roof of multipartite entanglement measures** — •Andreas Osterloh
SYEN 1.5	Thu	16:00–16:30	H1	**Decoherence induced by interacting quantum spin baths** — •Rosario Fazio
SYEN 1.6	Thu	16:30–17:00	H1	**Sweep a qubit to learn about its environment** — •Peter Hänggi

Sessions

TT 1.1–1.7	Mon	9:30–11:15	H18	**Superconductivity - Fabrication and Characterization**
TT 2.1–2.12	Mon	9:30–12:45	H19	**Quantum-Critical Phenomena**
TT 3.1–3.12	Mon	9:30–13:00	H20	**Quantum Coherence and Quantum Information Systems I**
TT 4.1–4.5	Mon	11:30–12:45	H18	**Solids at Low Temperature - Materials**
TT 5.1–5.13	Mon	14:00–18:00	H18	**Correlated Electrons - (General) Theory**
TT 6.1–6.11	Mon	14:00–17:00	H19	**Nanoelectronics III - Molecular Electronics**
TT 7.1–7.8	Mon	14:00–16:00	H20	**Quantum Coherence and Quantum Information Systems II**
TT 8.1–8.48	Mon	14:00–17:45	Poster A	**Superconductivity - Poster Session**
TT 9.1–9.6	Mon	16:15–18:00	H20	**Superconductivity - Heterostructures, Andreev Scattering, Proximity Effect, Coexistence**
TT 10.1–10.13	Tue	9:30–13:00	H18	**Superconductivity - Properties, Electronic Structure, Order Parameter**
TT 11.1–11.10	Tue	9:30–12:15	H19	**Quantum Impurities, Kondo Physics**
TT 12.1–12.11	Tue	9:30–13:00	H20	**Symposium "Coated HTS Conductors"**
TT 13.1–13.8	Tue	14:00–17:50	H18	**Symposium "Superconductivity and Magnetism in Lamellar Cobaltates"**
TT 14.1–14.18	Tue	14:00–19:15	H19	**Spin Systems and Itinerant Magnets**
TT 15.1–15.10	Tue	14:00–17:15	H20	**Superconductivity - Tunneling, Josephson Junctions, SQUIDs**
TT 16.1–16.4	Tue	18:00–20:00	H20	**Symposium "50 Years BCS Theory"**
TT 17.1–17.15	Wed	14:00–18:00	H18	**Heavy Fermions**
TT 18.1–18.12	Wed	14:00–17:15	H19	**Nanoelectronics I - Quantum Dots, Wires, Point Contacts**
TT 19.1–19.7	Wed	14:00–18:00	H20	**Symposium "Terahertz Detectors"**
TT 20.1–20.84	Wed	14:00–17:45	Poster A	**Correlated Electrons - Poster Session**
TT 21.1–21.20	Wed	14:00–17:45	Poster A	**Solids at Low Temperature - Poster Session**
TT 22.1–22.13	Thu	9:30–13:00	H18	**Low-dimensional Systems - Materials**
TT 23.1–23.11	Thu	9:30–12:30	H19	**Nanoelectronics II - Spintronics and Magnetotransport**
TT 24.1–24.7	Thu	9:30–12:50	H20	**Symposium "Condensed Matter Phases in Ultracold Atoms"**
TT 25.1–25.7	Thu	14:00–15:45	H18	**Quantum Liquids, Bose-Einstein Condensates, Ultracold Atoms, ...**
TT 26.1–26.13	Thu	14:00–17:30	H19	**Metal-Insulator Transition**
TT 27.1–27.6	Thu	14:00–16:40	H20	**Symposium "Graphene"**
TT 28.1–28.55	Thu	14:00–17:45	Poster A	**Transport - Poster Session**
TT 29.1–29.7	Thu	16:00–17:45	H18	**Superconductivity - Mechanisms, Phase Diagram, Competing Order**
TT 30.1–30.8	Thu	17:00–19:00	H20	**Superconductivity - Cryodetectors**
TT 31.1–31.6	Thu	17:45–19:15	H19	**Low-dimensional Systems - Models I**
TT 32.1–32.5	Thu	18:00–19:15	H18	**Fluctuations and Noise**
TT 33.1–33.10	Fri	10:15–13:00	H18	**Low-dimensional Systems - Models II**
TT 34.1–34.10	Fri	10:15–13:00	H19	**Superconductivity - Vortex Dynamics, Vortex Phases, Pinning**

Annual General Meeting of the Section Low Temperature Physics

Donnerstag 19:30–20:00 H19

- Frühjahrstagung 2007, Statistics
- Themenkreise, Symposien
- Bericht: DPG und AKF Sitzungen
- Frühjahrstagung 2008

- Verschiedenes

TT Time Table

PV: Plenary Talk ; ÖAV: Public Talk; HV: Invited Talk ; SY: Symposium
SC: Superconductivity ; CE: Correlated Electrons ; TR: Transport ; SLT: Solids at Low Temperature

Monday 26/03/07

8:30 *PV Louie* H1

9:30-11:15 **TT1** H18
SC - Fabrication and Characterization

11:30-12:45 **TT4** H18
SLT - Materials

9:30-12:45 **TT2** H19
CE - Quantum-Critical Phenomena

9:30-13:00 **TT3** H20
TR - Quantum Coherence and Quantum Information Systems I

9:30 HV Ilichev

9:30-13:20 **SYSS** H1
SY Spins in Semiconductors

13:00 *Talks and Discussion "Hirschindex"* H1

14:00-18:00 **TT5** H18
CE - (General) Theory

14:00 HV Reining

16:00 HV Bulla

14:00-17:00 **TT6** H19
TR - Nanoelectronics III Molecular Electronics

14:00-16:00 **TT7** H20
TR - Quantum Coherence and Quantum Information Systems II

16:15-18:00 **TT9** H20
SC - Heterostructures, Andreev Scattering, Proximity Effect, Coexistence

17:00 HV Beckmann

14:00-17:45 **TT8** Poster A
SC - Poster Session

14:45-17:30 **HL11** H15
Quantum Dots & Wires: TR Properties I

16:15-17:45 **DY17**
Quantum Decoherence

18:00 *PVs Paetzold / Bessenroth-Weberpals* H1

Tuesday 27/03/07

8:30 *PV Lemke* H1

9:30-13:00 **TT10** H18
SC - Properties, Electronic Structure, Order Parameter

9:30-12:15 **TT11** H19
CE - Quantum Impurities, Kondo Physics

9:30-13:00 **TT12** H20
SC - SY Coated HTS Conductors

9:30 HV Holzapfel

10:45-13:00 **HL20** H14
Spin-controlled TR I

13:00 *Max-Planck-Preisträger-Vortrag Lebowitz* H1

14:00-17:50 **TT13** H18
SC - SY SC & Magnetism in Lamellar Cobaltates

14:00 HV Ding
14:30 HV Yoshimura

14:00-19:15 **TT14** H19
CE - Spin Systems and Itinerant Magnets

15:00 HV Mössner

14:00-17:15 **TT15** H20
SC - Tunneling, Josephson Junctions, SQUIDs

15:30 HV Goldobin
16:00 HV Meyer

14:00-16:00 **HL24** H14
Spin-controlled TR II

14:00-17:00 **HL25** H15
Quantum Dots & Wires: TR Properties II

15:00-17:00 **HL27** H1
SY BEC in Semiconductors

17:00 *PV Hoodbhoy "Islam and Science"* H1

18:00 *PV Krige* H1

18:00-20:00 **TT16** H20
SC - SY 50 Years BCS

18:00 Wölfle
18:30 Steglich
19:00 Hanke
19:30 Mannhart

Wednesday 28/03/07

8:30 *PVs Zabel / Imamoglu* H1

10:30 **Festsitzung** H1

14:15 *Gaede-Preisträger-Vortrag* H1

14:00-18:00 **TT17** H18
CE - Heavy Fermions

14:00-17:15 **TT18** H19
TR - Nanoelectronics I
Quantum Dots, Wires, Point Contacts

14:00-18:00 **TT19** H20
SC - SY THz Detectors
14:00 HV Zmuidzinas
14:40 HV Mauskopf

14:00-17:45 **TT20** Poster A
CE - Poster Session

14:00-17:45 **TT21** Poster A
SLT - Poster Session

18:00 Mitgliederversammlung der DPG H1

20:00 *ÖAV Arzt* H1

Thursday 29/03/07

8:30 *PV Schottky-Preisträger-Vortrag Finley* H1

9:30-13:00 **TT22** H18
CE - Low-dimensional Systems - Materials

9:30-12:30 **TT23** H19
TR - Nanoelectronics II
Spintronics and Magnetotransport

9:30-12:50 **TT24** H20
SLT - SY Condensed Matter Phases in Ultracold Atoms
9:30 HV Demler
10:00 HV Köhl

9:30-13:00 **MA21** H10
9:30 HV Fisk

10:00-12:30 **HL36** H1
HL - SY Graphene

12:30-12:45 **HL42** H13
Metall-Isolator-Übergänge

13:00 *Stern-Gerlach-Preisträger-Vortrag Grünberg* H1

14:00-15:45 **TT25** H18
SLT - Quantum Liquids, Bose-Einstein Condensates, Ultracold Atoms, ...

16:00-17:45 **TT29** H18
SC - Mechanisms, Phase Diagram, Competing Order

18:00-19:15 **TT32** H18
TR - Fluctuations & Noise

14:00-17:30 **TT26** H19
CE - Metal-Insulator Transition

17:45-19:15 **TT31** H19
CE - Low-dimensional Systems - Models I

14:00-16:40 **TT27** H20
CE - SY Graphene
14:00 HV Katsnelson
15:20 HV Trauzettel

17:00-19:00 **TT30** H20
SC - Cryodetectors

14:00-17:45 **TT28** Poster A
TR - Poster Session

14:00-17:00 **SYEN** H1
SY Entanglement

19:30 Annual General Meeting of the Section Division Low Temperature Physics H19

Friday 30/03/07

8:30 *PVs Norskov / Joanny* H1

10:15-13:00 **TT33** H18
CE - Low-dimensional Systems - Models II

10:15-13:00 **TT34** H19
SC - Vortex Dynamics, Vortex Phases, Pinning

11:00-13:30 **HL52** H14
TR Properties

TT 1: Superconductivity - Fabrication and Characterization

Time: Monday 9:30–11:15 Location: H18

TT 1.1 Mon 9:30 H18

Critical state in current-carrying NbN thin-film structures — •Konstantin Ilin[1], Michael Siegel[1], Andreas Engel[2], Holger Bartolf[2], Andreas Schilling[2], Eugen Hollmann[3], Alexei Semenov[4], Andrey Smirnov[4], and Heinz-Wilhelm Hübers[4] — [1]Institute of Micro- and Nano-Electronic Systems, University of Karlsruhe, Germany — [2]Physics Institute, University of Zurich, Switzerland — [3]Research Centre Jülich, Germany — [4]DLR Institute of Planetary Research, Berlin, Germany

Superconducting NbN thin films are widely used for fabrication of detectors of electromagnetic radiation: single-photon detectors (SPD) and hot-electron mixers (HEM). While SPD is a meander line of width smaller than 100 nm, the key part of HEM is a few micrometers wide bridge with length of 200 - 300 nm. We report on a study of current-generated critical states in NbN bridges made from ultra-thin (< 10 nm) films. The films were deposited by reactive magnetron sputtering onto heated Si and sapphire substrates and patterned by electron-beam lithography and ion-milling to form bridges of width from 100 nm up to 10 μm. The critical current value of all bridges was measured in the temperature range from 2 K up to Tc. We observed significant variations of Ic(T) curves with the bridge widths. Sub-micrometer wide structures demonstrate almost standard dependencies of Ic on temperature, which can be described by the Ginzburg-Landau theory. Bridges of several micrometers in width show strongly non-monotonic Ic(T) dependencies. Mechanisms determining the current-carrying ability of the bridges made from ultra-thin NbN films will be discussed.

TT 1.2 Mon 9:45 H18

Optimization of superconducting/normal metal bi-layers for antenna structures of Hot-Electron Mixers — •Axel Stockhausen[1], Konstantin Ilin[1], Michael Siegel[1], Alexei Semenov[2], Andrey Smirnov[2], and Heinz-Wilhelm Huebers[2] — [1]Institute of Micro- and Nano-Electronic Systems, University of Karlsruhe, Karlsruhe, Germany — [2]DLR e.V. Institute of Planetary Research, Berlin-Adlershof, Germany

Hot-Electron Mixers operational in the THz frequency range are made from an ultra-thin (< 5 nm) NbN superconducting film, which is in direct contact with an antenna structure from a thick (about 300 nm) gold layer. Usually titanium or chromium in-situ deposited films are used as a buffer layer for the gold film. This leads to suppression of superconductivity in the ultra-thin NbN film due to the proximity effect and worsening of the device performance. To support the superconducting energy gap in the ultra-thin NbN film a buffer layer of superconducting material can be used instead of a normal metal. We report results on the development of deposition processes of superconducting Nb, NbN thin films, and Nb/Au and NbN/Au bi-layer structures. The superconducting films of Nb and NbN were deposited by magnetron or reactive magnetron sputtering of Nb target onto Si substrate kept at room temperature. In-situ Ar ion milling technique was used for pre-cleaning of the substrate surface before deposition. The dependencies of superconducting and normal state properties of the Nb and NbN films and multi-layer structures on deposition conditions will be presented and discussed.

TT 1.3 Mon 10:00 H18

Phase Slip in Thin Superconducting Wires — •Jonathan Eroms, Toeno van der Sar, Manohar Kumar, Ad Verbruggen, Kees Harmans, and Hans Mooij — Kavli Institute of Nanoscience, Delft University of Technology, P.O. Box 50 46, NL-2600GA Delft, The Netherlands

We experimentally investigate thermal and quantum phase slip in thin wires of amorphous NbSi. Quantum phase slip could ultimately be employed in a new type of superconducting qubit, but clear experimental evidence is scarce up to now. We focus on sputtered NbSi films with lithographically defined wires, since this will offer more flexibility for more complex devices. The sheet resistance, transition temperature and long-term stability of various film compositions and thicknesses were studied. The wires are fabricated with high-resolution e-beam lithography, using HSQ resist, a Leica EBPG 5000+ lithography tool and SF_6/He-based reactive ion etching. Line widths down to less than 15 nm are achievable. Transport in the wires was measured in a ^{3}He-cryostat, and also in a dilution refrigerator with extensive filtering. Wires with a normal state resistance per length of more than 35 Ω/nm deviate from the LAMH theory of thermally activated phase slip and show a saturation of the resistance at low temperature, which could point to quantum phase slip.

TT 1.4 Mon 10:15 H18

Masked ion-beam nano-patterning of high-T_c superconducting thin films — •Khurram Siraj[1], Johannes Pedarnig[1], Dieter Bäuerle[1], Herbert Richter[2], Wolfgang Lang[2], Renata Kolarova[3], Peter Bauer[3], Leopold Palmetshofer[4], and Christine Hasenfuss[4] — [1]Institut f. Angewandte Physik, Universität Linz, A-4040 Linz — [2]Institut f. Materialphysik, Universität Wien, A-1090 Wien — [3]Institut f. Experimentalphysik, Universität Linz, A-4040 Linz — [4]Institut f. Halbleiter- und Festkörperphysik, Universität Linz, A-4040 Linz

High-T_c superconducting (HTS) thin films are especially interesting for future nano-electronic devices. Masked ion-beam structuring (MIBS) is a promising technique to fabricate artificial HTS thin film nanostructures in a direct and single-step process.

Irradiation of vicinal $YBa_2Cu_3O_{7-d}$ (YBCO) thin films with light ions of low energy increases the normal state in-plane and out-of-plane resistivities and suppresses the critical temperature T_c without destroying the film crystal framework.

MIBS is employed for nano-structuring of YBCO thin films into lines, arrays and dots (size approx. 60 nm). Computer simulations (SRIM, MARLOWE) indicate that light-ion projection patterning can produce YBCO thin film nano-structures 10 nm in size.

This work is supported by the Austrian Science Fund FWF, the Micro@Nanofabrication Austria MNA Network (Austrian Federal Ministry for Economic Affairs and Labour), and the Higher Education Commission (HEC) Pakistan.

TT 1.5 Mon 10:30 H18

Effect of different carbon dopants on the superconducting properties of mechanically alloyed MgB_2 — •Marko Herrmann[1], Wolfgang Hässler[1], Christian Rodig[1], Margitta Schubert[1], Manfred Ritschel[2], Bernhard Holzapfel[1,3], and Ludwig Schultz[1,3] — [1]Institute of Metallic Materials, IFW Dresden, P.O. Box: 270116, D-01171 Dresden, Germany — [2]Institute for Solid State Research, IFW Dresden, P.O. Box: 270116, D-01171 Dresden, Germany — [3]Dresden University of Technology, Department of Physics, D-01062 Dresden, Germany

Doping with carbon both in its elemental state as well as present within carbon compounds is the method of choice for enhancing the superconducting properties of MgB_2. Precursor powders of carbon-doped MgB_2 were prepared by mechanical alloying. This preparation, successfully applied at ambient temperature, produced nanocrystalline, partially reacted powders. The high reactivity of the milled powders promotes the formation of MgB_2 at reduced temperatures around 600°C to 650°C. Compared to other in-situ preparation techniques, bulk samples of undoped mechanically alloyed MgB_2 show a high J_c of 1 x 10^6 A/cm^2 in self-field at 7.5 K and critical fields H_{c2} of 20 T. This can be explained by the high density of grain boundaries, which act as pinning centers and enhance the critical current density remarkably. A comparison of promising carbon dopants like carbon nanotubes and silicon carbide is presented. We show the influence of these dopants on the critical transition temperature, lattice parameter, critical field and critical current density of bulk and tape samples.

TT 1.6 Mon 10:45 H18

Correlation of Jc and microstructure in SiC added MgB_2 wires — •Balaji Birajdar[1], Nicola Peranio[1], Pavol Kováč[2], Wacek Pachla[3], and Oliver Eibl[1] — [1]Institut für Angewandte Physik, Universität Tübingen, Auf der Morgenstelle 10, D-72076 Tübingen, Germany — [2]Institute of Electrical Engineering, Dúbravska cesta 9, 842 39 Bratislava, Slovakia — [3]Institute of High Pressure Physics, Sokolowska 29/37, 01-142 Warsaw, Poland

Addition of SiC is known to enhance the critical current density (J_c) of MgB_2 wires. In this work, nano-crystalline SiC added MgB_2 wires are prepared by the powder-in-tube technique using different processing technologies. In ex-situ wires the powder is pre-reacted MgB_2+SiC and the annealing temperature is about 950 °C. In in-situ wires the

powder is Mg+2B+SiC and the annealing temperature is about 650 °C. The J_c's of the wires were found to differ by orders of magnitude. The best wires yielded a J_c of 10 000 A/cm^2 at B=9.7 T and T=4.2 K. Advanced electron microscopy techniques like EDX elemental mapping in SEM and TEM, and electron spectroscopic imaging (ESI) in TEM were used to study the microstructure of these wires on different length scales. The microstructure shows granularity (ex-situ samples) and incomplete phase formation (in-situ samples). Si is oxidised due to the high annealing temperature in ex-situ samples and forms Mg_2Si in in-situ prepared samples. C-doping of MgB_2 by dissolved SiC might play a role and would increase the B_{c2} and J_c. Measurement of the C-content by SEM-EDX in MgB_2 is inaccurate, the minimum detectable mass fraction of C in MgB_2 is about 1.7 at.%.

TT 1.7 Mon 11:00 H18

Evidence of superconductivity in $DyRh_4B_4$ compound — •Anke Köhler[1], Günter Behr[1], Günter Fuchs[1], Konstantin Nenkov[1], and Laxmi Chand Gupta[1,2] — [1]IFW Dresden, P.O.Box 270116, D-01171 Dresden, Germany — [2]Guest Scientist

Several $R\mathrm{Rh}_4\mathrm{B}_4$ (R = rare earth elements) are known to crystallize in *pt* (primitive tetragonal), *bct* (body-centered tetragonal) and the *or* (orthorhombic) structures. A number of them become superconducting. But so far, the Dysprosium compound is known to form only in the *pt*-structure and does not exhibit superconductivity. We examined the possibility of $DyRh_4B_4$ crytallizing in *bct*- or *or*-structures and exhibiting superconductivity. We synthesized polycrystalline samples containing Dy, Rh and B by arc-melting followed by an annealing process. The samples were characterized by electron EPMA and X-ray diffraction. Beside the desired $DyRh_4B_4$ composition we found a fraction of $DyRh_3B_2$ and a small amount of some other phases, which significantly got reduced by annealing. Unannealed and annealed samples contain a majority superconducting phase of the composition $DyRh_4B_4$, T_c = 4.4 K, as was shown by ac-susceptibility measurements. The as-grown samples also contain a ferromagnetic phase that is different from the superconducting one and vanishes nearly completely by annealing. In contrast, the superconducting volume fraction ($\approx 50\%$) does not noticeably change by annealing or further melting. It seems to us that the superconducting phase is orthorhombic. Further work is in progress to check this.

TT 2: Quantum-Critical Phenomena

Time: Monday 9:30–12:45 Location: H19

TT 2.1 Mon 9:30 H19

The 'via cuprata' from antiferromagnetic to ferromagnetic Heisenberg chains and Li_2ZrCuO_4 as a missing link near the quantum critical point — •S.-L. Drechsler[1], J. Richter[2], J. Malek[1,3], M. Schmitt[4], H. Rosner[4], N. Tristan[1], O. Volkova[5], A. Vasiliev[5], and B. Buechner[1] — [1]IFW-Dresden, PF 270116, D-01171 Dresden — [2]Universität Magdeburg — [3]Institute of Physics, ASCR, Praha, Czech Rep. — [4]MPI CPfS Dresden — [5]Lomonosov-University, Moscow, Russia

We consider 9 magnetic chain cuprates with ferromagnetic nearest neighbor exchange J_1 and antiferromagnetic next-nearest neighbor exchange J_2 from the vicinity of the quantum critical point (QCP) for $\alpha_c = -J_2/J_1 = 0.25$ up to 10. Approaching α_c the maximum position T_m of the magnetic susceptibility $\chi(T)$ tends to 0, whereas $\chi(T_m)$ monotonously increases. The recently synthesized Li_2ZrCuO_4, which contains spin-1/2 chains of edge-shared CuO_4 plaquettes, is close to α_c and shows therefore a strong field dependence of the thermodynamical properties. Fitting $\chi(T)$ and the specific heat, $\alpha \sim 0.3$ was found [1]. Here, we present also a microscopic consideration of the origin of the relative large $J_1 \approx$ -30meV within the framework of an appropriate five-band extended Hubbard model including the ferromagnetic direct exchange K_{pd} as well as the Hund's rule coupling on O sites. In addition, we found that the obtained sizeable interchain coupling dominates the saturation field due to the vicinity of the QCP.

[1] S.-L. Drechsler *et al.* Phys. Rev. Lett. **98** (2007), accepted.

TT 2.2 Mon 9:45 H19

Thermoelectric transport in the vicinity of a superconductor-metal quantum phase transition in nanowires — •Bernd Rosenow, Adrian Del Maestro, and Subir Sachdev — Department of Physics, Harvard University, Cambridge, MA 02138, USA

We consider the field theory for a zero temperature transition between superconducting and diffusive metallic states in very thin wires due to a cooper pair breaking mechanism, e.g. a magnetic field in the wire direction or disorder in an unconventional superconductor. The critical theory contains current reducing fluctuations in the guise of both quantum and thermally activated phase slips. In a large-N limit, we calculate the universal dependence of electrical and thermal conductivity on both pair breaking strength and temperature. We find that the conductivity has a non-monotonic temperature dependence on the metallic side of the transition and that the Wiedemann-Franz law is obeyed at low temperatures. In the quantum critical region, we study the dynamics of a two-component order paramter field via Monte Carlo simulation of a Langevin equation and compare with the large-N result.

TT 2.3 Mon 10:00 H19

Low-temperature magnetic properties of novel spin-dimer systems synthesized by bridging Cu(II) ions with modified hydroquinone ligands — •Y Tsui[1], U Tutsch[1], A Brühl[1], K Remović-Langer[1], V Pashchenko[1], B Wolf[1], M Lang[1], T Kretz[2], H-W Lerner[2], M Wagner[2], A Salguero[3], B Rahaman[4], T Saha-Dasgupta[4], and R Valentí[3] — [1]Physikalisches Institut, J.W. Goethe-Universität, Frankfurt, Germany. — [2]Institut für Anorganische Chemie, J.W. Goethe-Universität, Frankfurt, Germany. — [3]Institut für Theoretische Physik, J.W. Goethe-Universität, Frankfurt, Germany. — [4]S.N. Bose Centre, Kolkata, India.

We have recently synthesized novel spin-dimer systems by bridging Cu(II) ions with hydroquinone linkers. By chemically modifying the hydroquinone linkers, spin-dimer systems with different intradimer and interdimer interactions are realized. These compounds include isolated and coupled spin-dimer systems. We will discuss the magnetic properties of these systems at low temperatures. In particular, we will focus on one of the 3D coupled spin-dimer systems, $[C_{36}H_{48}Cu_2F_6N_8O_{12}S_2]$ (TK91). Thermodynamic and magnetic measurements on TK91 suggest that a field-induced phase transition takes place at very low temperatures ($T \lesssim 0.2$K) and at fields between ∼5.8 and ∼6.5T. Such a phase transition has been observed in other spin-dimer systems and was interpreted as the Bose-Einstein condensation (BEC) of magnons. The ability to tune the magnetic interactions in TK91 will make it possible to explore the BEC phenomenon in magnetic systems under various conditions.

TT 2.4 Mon 10:15 H19

Anomalous thermodynamics of spin-gap systems close to quantum phase transitions — •T. Lorenz[1], S. Stark[1], O. Heyer[1], H. Tanaka[2], and K. Krämer[3] — [1]II. Phys. Inst., University of Cologne, Germany — [2]Dep. of Phys., Tokyo Inst. of Tech., Japan — [3]Dep. of Chem. and Biochem., Univ. of Bern, Switzerland

Very rich and fascinating physical properties are predicted for various theoretical models of coupled spin-1/2 dimers. $TlCuCl_3$ and $(C_5H_{12}N)_2CuBr_4$ can be viewed as model systems for three- and one-dimensionally coupled spin-1/2 dimers, respectively [1]. Both have nonmagnetic singlet ground states, but moderate fields of about 6 Tesla are sufficient to close the spin-gap to the first excited triplet states. Due to the three-dimensional couplings larger fields induce a Néel order in $TlCuCl_3$, while in the spin-ladder material $(C_5H_{12}N)_2CuBr_4$ a crossover takes place to a state, which can be mapped on a Luttinger-liquid phase. In the zero-temperature limit these transitions represent examples of quantum phase transitions, whose control parameter may be easily tuned by variation of the magnetic field. We present a high-resolution study of the thermal expansion and magnetostriction on both compounds and compare our experimental results to the theoretically predicted behavior in the vicinity of a pressure-dependent quantum critical point [2].

This work was supported by the DFG through SFB 608.

[1] T. Lorenz et al., cond-mat/0609348 (2006), B.C. Watson et al., PRL 86, 5168 (2001). [2] L.J. Zhu et al., PRL 91, 066404 (2003), M. Garst and A. Rosch , PRB 72, 205129 (2005).

TT 2.5 Mon 10:30 H19

High pressure quantum phase transition in the weakly coupled spin cluster system $Cu_2Te_2O_5Br_2$ — •Hans-Henning Klauss[1], Christopher Mennerich[1], Hemke Maeter[1], Hannes Kühne[1], Peter Lemmens[1], Jochen Litterst[1], Hubertus Luetkens[2], Alex Amato[2], Rie Takagi[3], and Mats Johnsson[3] — [1]IPKM, TU Braunschweig, Braunschweig, Germany — [2]Paul-Scherrer-Institut, Villigen, Switzerland — [3]Dept. of Inorganic Chem., Stockholm Univ., Stockholm, Sweden

Tetragonal $Cu_2Te_2O_5Br_2$ contains clusters of four Cu^{2+} (S = 1/2) in a planar coordination. These tetrahedra form weakly coupled sheets within the crystallographic a-b plane. Therefore, this system is ideal to study the interplay between the spin frustration on a tetrahedron with localized low-energy excitations and collective magnetism induced by inter-tetrahedra couplings. In this material a strongly reduced magnetic transition temperature $T_N = 11.4$ K in comparison with a dominant magnetic exchange of 40 K is found.

We examined the quantum critical behaviour of polycrystalline $Cu_2Te_2O_5Br_2$ in ZF muSR experiments under external pressures. We observed a continuous decrease of the magnetic phase volume and of the sublattice magnetization, studied via the spontaneous muon spin precession frequency, with increasing pressure. The measurements at 6 kbar did not show any sign of static magnetic correlations down to 0.3 Kelvin. We conclude that this system shows a quantum critical point at 6 kbar where the magnetic ordered phase disappears and a spin liquid ground state is formed.

TT 2.6 Mon 10:45 H19

Quantum phase transitions and dimensional reduction in antiferromagnets with inter-layer frustration — •Oliver Rösch, Inga Fischer, and Matthias Vojta — Institut für Theoretische Physik, Universität zu Köln

We discuss phase transitions of quasi-two-dimensional antiferromagnets with a fully frustrated inter-layer interaction. Using symmetry arguments in a perturbation expansion for the order parameter theory and applying the bond-operator method beyond the harmonic approximation, we calculate the magnetic excitation spectrum in different parameter regimes. We consider various crossovers in the vicinity of the quantum critical points and the finite-temperature transitions. We also discuss the relation of our results to recent experiments on $BaCuSi_2O_6$ which indicated the possibilty of dimensional reduction through geometric frustration.

15 min. break

TT 2.7 Mon 11:15 H19

Interplay between chiral symmetry breaking and spinon confinement in Mott insulators — •Flavio Nogueira and Hagen Kleinert — Institut für Theoretische Physik, Freie Universität Berlin

It is well known that compact quantum electrodynamics in 2+1 dimensions (QED_3) is an effective theory Mott insulators near the so called resonating valence-bond (RVB) flux phase. We have recently demonstrated the stability of the spin liquid for a large enough number of spinon species [1]. However, the effect of chiral symmetry breaking (CSB), which leads to the appearence of spin density wave, was not considered. CSB is known to occur in noncompact QED_3. In this work we discuss the interplay between CSB and confinement in the compact case and point out the consequences for the stability of spin liquids for the physically relevant number of spinon species, N=2.

[1] F. S. Nogueira and H. Kleinert, Phys. Rev. Lett. **95**, 176406 (2005)

TT 2.8 Mon 11:30 H19

Spontaneous Fermi surface symmetry breaking in $Sr_3Ru_2O_7$ — •Hiroyuki Yamase and Andrey Katanin — Max-Planck-Institute for Solid State Research, Heisenbergstrasse 1, 70569 Stuttgart, Germany

The most salient features observed around a metamagnetic transition in $Sr_3Ru_2O_7$ are well captured in a simple model for spontaneous Fermi surface symmetry breaking under the Zeeman magnetic field, without invoking a putative quantum critical point. The Fermi surface symmetry breaking happens in both a majority and a minority band but with different magnitude of the order parameter, when either band is tuned close to van Hove filling by the magnetic field. The transition is second order for high temperature (T) and changes into first order for low T. The first order transition is accompanied by a metamagnetic transition. The uniform magnetic susceptibility and the specific heat divided by temperature show strong T dependence, especially log$T$ divergence at van Hove filling. The Fermi surface instability then cuts off these non-Fermi liquid behaviors and gives rise to a specific heat jump and a cusp in the susceptibility at T_c.

TT 2.9 Mon 11:45 H19

Logarithmic Fermi-liquid breakdown in $Nb_{1.02}Fe_{1.98}$ — •Manuel Brando[1], Dennis Moroni-Klementowicz[2], Carsten Albrecht[2], William Duncan[2], Daniel Gruener[1], Guido Kreiner[1], Rafik Ballou[3], Bjorn Fak[4], and Malte Grosche[2] — [1]Max-Planck-Institut für Chemische Physik fester Stoffe, Nöthnitzer Strasse 40, D-01187 Dresden, Germany — [2]Dept. of Physics, Royal Holloway, University of London, Egham TW20 0EX, UK — [3]Laboratoire Louis Néel, CNRS, B.P. 166, 38042 Grenoble Cedex 9, France — [4]Commissariat à l'Energie Atomique, Département de Recherche Fondamentale sur la Matière Condensée, SPSMS, 38054 Grenoble, France

We report measurements of the heat capacity C and of the resistivity ρ in stoichiometric and slightly Nb-rich $NbFe_2$ samples, including a single crystal with the composition $Nb_{1.02}Fe_{1.98}$, which on the phase diagram is located very close to the quantum critical point ($T_N \simeq 2.8$K). Both the resistivity and the heat capacity of the nearly quantum-critical single crystal display striking, robust non-Fermi liquid temperature dependences: while the heat capacity coefficient $\gamma = C/T$ diverges weakly as $C/T \sim \log T$ from 4K down to 0.1K, in line with theoretical predictions for 3-D *ferromagnetic* quantum criticality, the resistivity follows a $T^{3/2}$ power-law, familiar from the case of MnSi and naively predicted for the proximity of an *antiferromagnetic* quantum critical point.

TT 2.10 Mon 12:00 H19

High-temperature echo of the quantum phase transition in $CeCu_{6-x}Au_x$ — •M. Klein[1], A. Nuber[1], H. v. Löhneysen[2,3], and F. Reinert[1] — [1]Universität Würzburg, Experimentelle Physik II, Am Hubland, 97074 Würzburg — [2]Universität Karlsruhe, Physikalisches Institut, D-76128 Karlsruhe — [3]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, D-76021 Karlsruhe

During the last years many experiments and theoretical investigations have been performed to explain the nature of quantum critical points (QCP) in heavy-fermion compounds. One important candidate of these compounds is $CeCu_{6-x}Au_x$ which goes from a paramagnetic metal to an antiferromagnetic metal as x increases. The QCP appears when the critical value of $x_c \sim 0.1$ is reached.
We have performed high-resolution photoemission experiments($\Delta E <$ 5 meV) on single crystals with different gold concentrations at temperatures in the range from $T = 15$ K to 60 K. Though these temperatures were much higher than the characteristic temperatures we see a significant jump in the spectral weight of the Kondo-resonance at x_c implying a sudden change in the correlation between localized 4f-electrons and conduction electrons. A comparison with NCA calculations allows a quantitative determination of the Kondo temperature and the crystal field energies. This finite temperature signatur is a further key to solve the question about the nature of the QCP in this system.

TT 2.11 Mon 12:15 H19

Multiple energy scales at a quantum critical point — •P. Gegenwart[1], T. Westerkamp[2], C. Krellner[2], Y. Tokiwa[3], S. Paschen[4], C. Geibel[2], F. Steglich[2], E. Abrahams[5], and Q. Si[6] — [1]I. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen — [2]Max-Planck Institute for Chemical Physics of Solids, 01187 Dresden — [3]Los Alamos National Laboratory, Los Alamos, New Mexico 87545, USA — [4]Institute for Solid State Physics, Vienna University of Technology, 1004 Vienna, Austria — [5]Center for Materials Theory, Department of Physics and Astronomy, Rutgers University, Piscataway, New Jersey 08855, USA — [6]Department of Physics & Astronomy, Rice University, Houston, TX 77005, USA

We report thermodynamic and transport measurements at the magnetic-field-driven quantum critical point in the heavy fermion metal $YbRh_2Si_2$. The data define a new energy scale, which approaches zero as the quantum critical point (QCP) is reached. This scale is distinct from the crossover scale below which Fermi liquid behavior is established. The collapse of multiple energy scales provides

evidence for a new type of quantum criticality, with critical excitations in addition to the slow fluctuations of the order parameter.

TT 2.12 Mon 12:30 H19

Electric transport at the quantum critical point in $YbRh_2Si_2$ — •Sven Friedemann[1], Niels Oeschler[1], Cornelius Krellner[1], Christoph Geibel[1], Silke Paschen[1,2], and Frank Steglich[1] — [1]Max Planck Institute for Chemical Physics of Solids, Noethnitzer Strasse 40, 01187 Dresden, Germany — [2]Vienna University of Technology, Karlsplatz 13, 1040 Wien, Austria

The heavy-fermion metal $YbRh_2Si_2$ exhibits pronounced non-Fermi liquid (NFL) behavior due to its vicinity to a quantum critical point (QCP). By applying small magnetic fields, $YbRh_2Si_2$ is driven from an antiferromagnetic state through the QCP towards the paramagnetic state. Currently, two scenarios for a system at this type of QCP are discussed: The spin-density-wave scenario at which heavy electrons are present on both sides of the QCP and the locally QCP at which the heavy electrons on the paramagnetic side disintegrate into localized magnetic moments and light conduction electrons on the magnetic side of the QCP. The field-dependent Hall effect as a measure of the Fermi volume is assumed to be the appropriate method to characterize the QCP in $YbRh_2Si_2$. As an extension to previous results [1] we present low temperature Hall-effect data of new high-quality samples which confirm a step in R_H for $T \to 0$ and thus support the local scenario. The T dependence of the height and the width of the crossover are discussed. Corresponding features are also observed in the magnetoresistance. Furthermore, the maximum of the Hall-effect at $T \approx 1\,\mathrm{K}$ is presumably due to the spin fluctuations in the NFL region.
([1] S. Paschen et al., Nature 432, 881 (2004))

TT 3: Quantum Coherence and Quantum Information Systems I

Time: Monday 9:30–13:00 Location: H20

Invited Talk TT 3.1 Mon 9:30 H20

Experimental investigation of superconducting flux qubits — •Evgeni Ilichev — Institute for Physical High Technology, P.O. Box

We have investigated systems consisting of one, two, three or four flux qubits. In order to determine the magnitude of the coupling energy, we have measured the magnetic susceptibility of the qubit system through their influence on the resonant properties of a weakly coupled high-quality tank circuit. We show, that the system's Hamiltonian could be completely reconstructed from measurements far away from the common degeneracy point of a flux qubit system. The subsequent measurements around this point show complete agreement with the theoretical predictions following from its Hamiltonian. The ground state anti-crossings of the system could be read-out directly from these measurements. For a three-flux-qubit system this allows the determination of the ground-state flux diagram in the complete three dimensional flux space. We have also demonstrated that the fixed coupling energy can be varied in a wide range: from several millikelvins up to several kelvins. Recently, we have also demonstrated a tuneable coupling between flux qubits.

TT 3.2 Mon 10:00 H20

Quasiparticle transitions in Josephson charge-phase qubits with radio frequency read-out — •Jens Könemann, Hermann Zangerle, Brigitte Mackrodt, Ralf Dolata, and Alexander Zorin — Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig

Tunneling of single quasiparticles in Josephson qubits operating on single Cooper pairs presents a serious problem. This tunneling instantly changes the working point of the qubit and, therefore, its charge state and transition frequency, which leads to decoherence. Moreover, one can expect both relaxation and excitation of the qubit induced by quasiparticle tunneling. We have investigated Al Josephson charge-phase qubits of SQUID-configuration inductively coupled to a radio-frequency tank circuit with a resonant frequency of about 77 MHz, thus enabling the readout of the state by measuring the Josephson inductance of the qubit. Depending on the flux and charge bias and the amplitude of rf-oscillations we have probed either a plain 2e-behavior in the dependence on gate charge corresponding to the ground state or a dynamic change of ground and excited states. The latter behavior is explained in terms of stochastic single quasi-particle tunneling onto and off the island of the qubit and, hence, possible transfer of energy from the quasiparticles to the qubit system. For this process we derive a selection rule which explains the observed suppression of the quasiparticle-induced transitions in the qubit operating in the magic point $q = e$

TT 3.3 Mon 10:15 H20

Temperature Dependence of Rabi Oscillations in Phase Qubits — •Jürgen Lisenfeld, Alexandr Lukashenko, and Alexey Ustinov — Physikalisches Institut III, Universität Erlangen-Nürnberg

We will present measurements of Josephson phase qubits which feature the phase eigenstates of a Josephson junction placed in a superconducting loop and biased at a magnetic flux close to one flux quantum. The phase qubit is controlled by resonant microwaves and read out by a dc-SQUID measuring its flux state. We have measured Al-based phase qubits with SiNx shunting capacitors made at UCSB [1] and our similarly designed circuits fabricated at Hypres foundry using a standard Nb-based fabrication process with SiO_2 insulation. Rabi oscillations decay at half-life times that are about 100 ns and 5 ns, respectively.

We find that the oscillation amplitude as well as decay time do not decrease up to the temperature, at which the thermal energy k_BT becomes comparable to the energy level separation. The oscillations disappear at about 400 mK for the Al qubits and at about 700 mK for the qubits made of Nb. Our data point towards non-thermal origin of decoherence limiting the low-temperature performance of the phase qubits.

[1] M. Steffen, et al. Phys. Rev. Lett. **97**, 050502 (2006)

TT 3.4 Mon 10:30 H20

Reading-out the state of a flux qubit by Josephson transmission line solitons — •Arkady Fedorov[1], Alexander Shnirman[1], Gerd Schoen[1], Andreas Poenicke[1], and Anna Anna Kidiyarova-Shevchenko[2] — [1]Institut für Theoretische Festkörperphysik and DFG-Center for Functional Nanostructures (CFN), Universität Karlsruhe, D–76128 Karlsruhe, Germany — [2]Microtechnology and Nanoscience Department, Chalmers University of Technology, 412 96 Gothenburg, Sweden

We describe the read-out process of the state of a Josephson flux qubit via solitons in a Josephson transmission line (JTL). We consider the situation where the qubit is inductively coupled to the JTL and the information about the state of the qubit is stored in the time delay of the soliton. To investigate the efficiency that can be achieved in the proposed measurement scheme for relevant experimental parameters we evaluate the delay time in three different setups: a) when the qubit is kept away from the symmetry point all the time; b) when the qubit is initially prepared at the symmetry point, but the approaching soliton pushes the qubit far from the symmetry point; c) when the qubit is near the symmetry point all the time. We analyze the relation between the delay time and the dissipation as well as the probability of errors introduced by the measurement. Finally, we compare the delay time with the characteristic time uncertainty due to jitter (thermal fluctuations) in the JTL, and we determine how many solitons are needed for a reliable measurement.

TT 3.5 Mon 10:45 H20

Dynamics of a flux qubit coupled to a nonlinear structured environment — •Marnix Wakker[1], Francesco Nesi[2], Cristiane Morais Smith[1], and Milena Grifoni[2] — [1]Institut for Theoretical Physics, University of Utrecht — [2]Institut for Theoretical Physics, University of Regensburg

We investigate the dynamical decoherence and dephasing of a quantum two-state system (qubit) where the environment is formed by a broadened localized nonlinear mode. This situation mimics recent experimental set-ups [1,2] where the flux qubit is coupled to a DC-SQUID, the latter used as a flux-sensitive Josephson inductor for qubit readout. Depending on the amplitude of the readout resonant driving, the SQUID behaves as a linear or a nonlinear oscillator. We consider the case of a flux qubit coupled to a SQUID considered as a nonlin-

ear environment, which is itself coupled to an Ohmic bath. For small nonlinearities, we can find an effective bath description for the environment seen by the qubit. The problem can in fact be mapped onto a spin-boson model with a structured spectral density containing two or more peaks. For vanishing nonlinearity, the spectral density shows a single braodened peak centered at the SQUID plasma frequency. By calculating the qubit's dynamics within the non-interacting-blip approximation, effects of the non-linearity show up in multiple Rabi peaks, a feature which could also be experimentally detected.

[1] P. Bertet *et* al., Phys. Rev. B **79**, R100501 (2004). [2] J.C. Lee *et* al., IEEE Trans. Appl. Superconductivity **15**, 841 (2005).

TT 3.6 Mon 11:00 H20

Quantum state preparation via Landau-Zener tunneling — •Sigmund Kohler[1], Martijn Wubs[1], Peter Hänggi[1], Keiji Saito[2], and Yosuke Kayanuma[3] — [1]Institut für Physik, Universität Augsburg — [2]University of Tokyo, Japan — [3]Osaka Prefecture University, Japan

The coupling of a qubit to a circuit-QED mode can induce Landau-Zener transitions of the qubit upon switching the magnetic flux that penetrates the superconducting loop. The adiabatic energies of this system are characterized by multiple exact and avoided level crossings, so that the usual two-level Landau-Zener formula is no longer applicable. We derive selection rules for the multi-level transitions and present an exact expression for the corresponding transition probabilities. Applications include quantum state preparations like single-photon generation and the controllable creation of qubit-oscillator entanglement.
[1] K. Saito, M. Wubs, S. Kohler, P. Hänggi, and Y. Kayanuma, Europhys. Lett. **76**, 22, (2006).

15 min. break

TT 3.7 Mon 11:30 H20

One-qubit laser and cooler — Julian Hauss[1], •Carsten Hutter[1,2], Arkady Fedorov[1], Alexander Shnirman[1], and Gerd Schön[1] — [1]Institut für Theoretische Festkörperphysik, Universität Karlsruhe, D-76128 Karlsruhe, Germany — [2]Department of Physics, Stockholm University, AlbaNova University Center, SE-10961 Stockholm, Sweden

We consider a setup performing Rabi spectroscopy of a superconducting qubit. The system consists of a slow electromagnetic or nanomechanical oscillator coupled to a resonantly driven superconducting qubit. When the Rabi frequency of the qubit coincides with the eigenfrequency of the oscillator the latter can be driven into a strongly non-equilibrium state. Experiments of this type have recently been performed [1].

We find that by introducing detuning in the driving of the qubit one can create a population inversion at the Rabi frequency and this can lead to a "lasing" behavior of the qubit-oscillator system. In particular we consider a situation when the qubit is kept at its symmetry point where the decoherence due to $1/f$ noise is minimal. Then the coupling to the oscillator is quadratic and the system realizes a "single-atom-two-photon laser".
[1] E. Il'ichev et *al.*, Phys. Rev. Lett. **91**, 097906 (2003)

TT 3.8 Mon 11:45 H20

Quantum Theory of Cavity-Assisted Sideband Cooling of Mechanical Motion — •Florian Marquardt[1], Joe P. Chen[2], Aashish A. Clerk[3], Jack G. E. Harris[2], and Steven M. Girvin[2] — [1]Arnold Sommerfeld Center for Theoretical Physics, Department für Physik und Center for NanoScience, Ludwig-Maximilians Universität München, Germany — [2]Department of Physics, Yale University, New Haven, USA — [3]Department of Physics, McGill University, Montreal, Canada

We present a fully quantum theory describing the cooling of a cantilever coupled via radiation pressure to an illuminated optical cavity. Applying the quantum noise approach to the fluctuations of the radiation pressure force, we derive the opto-mechanical cooling rate and the minimum achievable phonon number. We find that reaching the quantum limit of arbitrarily small phonon numbers requires going into the good cavity (resolved phonon sideband) regime where the cavity linewidth is much smaller than the mechanical frequency and the corresponding cavity detuning. This is in contrast to the common assumption that the mechanical frequency and the cavity detuning should be comparable to the cavity damping.

TT 3.9 Mon 12:00 H20

Phase Purcell effect and the crossover to strong coupling in dispersive circuit QED — •Ioana Serban[1,2], Frank Wilhelm[2], and Enrique Solano[1] — [1]Ludwig-Maximilians-Universitaet, Munich, Germany — [2]Institute for Quantum Computing, Waterloo, Canada

We study the decoherence of a superconducting qubit due to the dispersive coupling to a damped harmonic oscillator. We go beyond the weak qubit-oscillator coupling, which we associate with a phase Purcell effect, and enter into an unexplored decoherence regime, solving a theoretical inconsistency in existing models: the divergence of the qubit dephasing rate in the absence of environment. Our results can be applied, with small adaptations, to a large variety of other physical systems, e.g. trapped ions and cavity QED, boosting theoretical and experimental decoherence studies.

TT 3.10 Mon 12:15 H20

2D Cavity Grid Quantum Computing — •Ferdinand Helmer[1], Jan von Delft[1], Matteo Mariantoni[2], Florian Marquardt[1], and Enrique Solano[1] — [1]Arnold-Sommerfeld-Center for Theoretical Physics, Ludwig-Maximilians-Universität, Munich, Germany — [2]Walther-Meissner-Institut, Garching/Munich, Germany

We propose a novel scheme for scalable solid state quantum computing, where superconducting on-chip microwave resonators (cavities) are arranged in a two-dimensional grid, coupling to superconducting qubits (charge or flux) at the intersections. We analyze how tasks of quantum information processing can be implemented in such a topology, including efficient two-qubit gates between any two qubits, initialization and read-out. The effects of decoherence, fabrication imperfections and inhomogeneities will be addressed. This work is supported by the SFB 631.

TT 3.11 Mon 12:30 H20

Theoretical and experimental studies of circuit QED systems — •Frank Deppe[1], Matteo Mariantoni[1], Shiro Saito[2], Takayoshi Meno[3], Kouichi Semba[2], Hideaki Takayanagi[4], and Rudolf Gross[1] — [1]Walther-Meißner-Institut, Garching/München, Germany — [2]NTT BRL, NTT Corp., Atugi, Japan — [3]NTT AT, NTT Corp., NTT, Japan — [4]Tokyo Univ. of Science, Tokyo, Japan

In recent years, the interaction between a superconducting qubit and and on-chip microwave resonator has been investigated in several theoretical and experimental studies. We performed microwave spectroscopy on a system composed of a superconducting flux qubit and the single mode of an LC circuit resonator. The LC resonator is formed by the capacitance and line inductance of the shunting circuit of the DC SQUID used to read-out the qubit state. Our implementation of circuit QED provides a counterpart to experiments where the state of the microwave field is detected. The spectroscopy data shows clear evidence of the coupled system. The coupling constant is of the order of a few tens of megahertz. We also performed simulations of a dissipation-less driven Jaynes-Cummings model in order to estimate the effective number of photons present in the resonator. A possible interesting application of our architecture would the generation of microwave single photons. This work is supported by the DFG via SFB 631.

TT 3.12 Mon 12:45 H20

Nonlinear interaction and two-mode squeezing with superconducting flux qubits. — Matteo Mariantoni[1], Frank Deppe[1], Rudolf Gross[1], Frank Wilhelm[2], and •Enrique Solano[3,4] — [1]Walther-Meissner-Institut, Garching, Germany — [2]IQC and University of Waterloo, Waterloo, Canada — [3]Ludwig-Maximilians-Universität, Munich, Germany — [4]Pontificia Universidad Católica del Perú, Lima, Peru

The interaction between superconducting quantum circuits and on-chip microwave resonators represents a rich field of research. We focus on the general, nonlinear interaction of a superconducting flux qubit with three modes of a coplanar wave-guide resonator and show how to implement, through suitable resonant conditions, a first-order Hamiltonian that yields nondegenerate, two-mode squeezing of the cavity field. Furthermore, we study the coherent properties of this engineered interaction and prove that it is able to generate a high degree of entanglement, while approaching perfect squeezing at the cavity output. Finally, we consider a realistic scenario including the presence of decoherence effects to evaluate the robustness of the proposed squeezing mechanism. This work is partially supported by the DFG via SFB 631.

TT 4: Solids at Low Temperature - Materials

Time: Monday 11:30–12:45 Location: H18

TT 4.1 Mon 11:30 H18

The ADRESS project at the Swiss Light Source: A beamline for RIXS and ARPES studies on correlated and nanostructured materials — •Thorsten Schmitt[1], Vladimir Strocov[1], Thomas Schmidt[1], Uwe Flechsig[1], Juraj Krempaski[1], Giacomo Ghiringhelli[2], Claudia Dallera[2], Lucio Braicovich[2], Marco Grioni[3], and Luc Patthey[1] — [1]Paul Scherrer Institut, Villigen PSI, Switzerland — [2]Politecnico di Milano, Italy — [3]EPFL, Switzerland

Resonant inelastic X-ray scattering (RIXS) is a powerful bulk-sensitive probe of the electronic structure of condensed matter with atomic and orbital sensitivity. Soft X-Ray Angle-Resolved Photoelectron Spectroscopy (ARPES) allows k-resolved investigations of the electronic structure and correlation effects with enhanced bulk sensitivity. New instrumentation for both, RIXS and Soft X-Ray ARPES, will become available at the ADvanced RESonant Spectroscopies (ADRESS) beamline at the Swiss Light Source (SLS) beginning from spring 2007. We report on construction and planned capabilities of the ADRESS beamline, following an optical scheme with a plane grating monochromator. The ADRESS beamline will deliver soft X-rays with variable polarization (circular and linear) between 0.4 and 1.8 keV at high resolving power of ˜28000 near 1 keV. The undulator for this beamline adopts an Apple-type scheme with 4 arrays of permanent magnets with a fixed magnetic gap. The RIXS end-station with an ultra-high resolution soft X-ray spectrometer (resolving power ˜12000 around 1 keV) will be installed on a rotating platform in order to study low-energy excitations as a function of momentum transfer.

TT 4.2 Mon 11:45 H18

Spin-phonon coupling in chromium spinels probed by infrared spectroscopy — •Torsten Rudolf[1], Christian Kant[1], Franz Mayr[1], Joachim Hemberger[1], Vladimir Tsurkan[1,2], and Alois Loidl[1] — [1]Experimental Physics V, Center for Electronic Correlations and Magnetism, University of Augsburg, D-86135 Augsburg, Germany — [2]Institute of Applied Physics, Academy of Sciences of Moldova, MD-2028 Chisinau, Republic of Moldova

The B-site spinels ACr_2X_4 with A=Cd, Zn, Hg and X=S, O and Se were systematically investigated by Fourier Transform Infrared Spectroscopy. The temperature and magnetic field dependence of the phonon spectra in a range from 5 K to 300 K and in fields of up to 7 T where studied. At the magnetic ordering temperature most compounds show significant splittings of the phonon modes, driven by spin-phonon coupling. $CdCr_2O_4$ and $ZnCr_2O_4$ are geometrically frustrated, $ZnCr_2S_4$ [1] is bond frustrated and $ZnCr_2Se_4$ [2] is bond frustrated, but dominated by ferromagnetic exchange. The pattern of splittings is different for the different compounds and crucially depends on the nature of frustration and of the resulting spin order. $HgCr_2S_4$ is almost a ferromagnet and exhibits no splitting of the eigenfrequencies, whereas $ZnCr_2Se_4$ is a prominent example of a spin-driven Jahn-Teller effect, where the splitting of the low-energy phonon mode can be fully suppressed in an external magnetic field.

[1] J. Hemberger *et al.*, Phys. Rev. Lett. **97**, 087204 (2006)
[2] T. Rudolf *et al.*, Spin-phonon coupling in $ZnCr_2Se_4$, *Preprint* cond-mat/0611041

TT 4.3 Mon 12:00 H18

Europium Tunneling in $Eu_8Ga_{16}Ge_{30}$ — •Raphaël P. Hermann — Institut für Festkörperforschung, Forschungszentrum Jülich GmbH, 52425 Jülich * — Dept of Physics, B5, Université de Liège, B-4000 Sart-Tilman, Belgium — Dept of Materials Science and Engineering, The University of Tennesee, Knoxville, Tennessee, 37996-2200, USA

We report on Mössbauer spectral and microwave absorption experiments that reveal the atomic tunneling of Eu in the ferromagnetic phase of the $Eu_8Ga_{16}Ge_{30}$ clathrate[1]. Single crystal neutron diffraction had revealed that Eu reside off-center in the clathrate cages[2] and a signature of the tunneling was found in elastic constant measurements[3]. Our measurements reveal the ground state tunneling of 75% of the Eu with a frequency of ∼450 MHz in good agreement with the expected frequency for an isolated tunneling atom in a double well potential. The presence of such well defined ionic tunneling in a crystalline solid may open the route to solid-state technological applications of the associated Rabi oscillations.

[1] Hermann R. P. *et al.*, Phys. Rev. Lett. 97, 017401 (2006).
[2] Sales B. C. *et al.*, Phys. Rev. B 63, 245113 (2001).
[3] Zerec I. *et al.*, Phys. Rev. Lett. 92, 185502 (2004).
* Current address

TT 4.4 Mon 12:15 H18

Effects of Nuclear Spins in Amorphous Glycerol on the Amplitude of Dielectric Polarization Echoes — •Masoomeh Bazrafshan[1], Gudrun Fickenscher[1], Kathrin Reinhold[1], Marek Bartkowiak[2], Herbert Zimmermann[3], Andreas Fleischmann[1], and Christian Enss[1] — [1]Kirchhoff-Institut für Physik, Universität Heidelberg — [2]Forschungszentrum Rossendorf, Dresden — [3]Max-Planck-Institut für Medizinische Forschung, Heidelberg

The properties of amorphous solids below a few Kelvin are determined by tunnelling systems. It has been shown that coupling of nuclear quadrupole moments to the tunnelling motion leads to magnetic field effects in non-magnetic glasses. We find that, in smaller B-fields, the presence of nuclear magnetic dipole moments interacting with each other by the magnetic dipole-dipole interaction results in similar magnetic field effects.

Both effects have been studied systematically with dielectric two-pulse polarization echoes on a series of partially deuterated glycerol samples. Decay measurements at very low temperatures show quantum beating with two different groups of frequencies, which can be attributed to the quadrupole energy splittings (˜130kHz) and the dipole-dipole splittings (˜30kHz). In addition, the beating amplitudes feature an unexpected temperature-dependent damping.

We present the measured data and compare the results with detailed numerical simulations. On this basis we draw possible conclusions about the microscopic nature of tunnelling systems in amorphous glycerol.

TT 4.5 Mon 12:30 H18

Relaxation mechanisms in low mechanical loss materials for interferometric gravitational wave detectors occurring at low temperatures — •Anja Zimmer[1], Ronny Nawrodt[1], Daniel Heinert[1], Christian Schwarz[1], Matthias Hudl[1], Wolfgang Vodel[1], Andreas Tünnermann[2], and Paul Seidel[1] — [1]Institut für Festkörperphysik, FSU Jena, Helmholtzweg 5, 07743 Jena — [2]Institut für Angewandte Physik, FSU Jena, Albert-Einstein-Straße 15, 07745 Jena

Interferometric gravitational wave detectors are highly sensitive instruments. To reduce the thermal noise of their optical components the operating temperature could be lowered which calls for materials offering low mechanical losses at these cryogenic temperatures. Therefore, systematic measurements have been done in a high precision experimental setup providing the ability to observe losses of at least 10^{-9} at the resonant frequencies of the samples in the temperature range of 5 to 300 K. Relaxation mechanisms leading to the mechanical losses are discussed for different materials.

This work was supported by the DFG under contract SFB Transregio 7.

TT 5: Correlated Electrons - (General) Theory

Time: Monday 14:00–18:00 Location: H18

Invited Talk TT 5.1 Mon 14:00 H18

Time-dependent density-functional theory: the framework, applications and recent developments — •Lucia Reining — LSI, CNRS-Ecole Polytechnique, Palaiseau, France

Time-Dependent Density Functional Theory (TDDFT) [1] is used with increasing success for the ab initio description of electronic excitations, measured for example in absorption, electron-energy loss or inelastic X-ray scattering spectroscopies. In fact, TDDFT correctly covers phenomena such as classical depolarization, the Fano effect due to interference of different excitations, or the appearance of bound exciton series in the bandgap of insulators. The description of these and many other interesting effects require of course different levels of approximation, for example concerning exchange-correlation effects.

This talk will give an overview of the spirit and the fundamental ingredients of TDDFT, in comparison to the alternative description of excitation spectra through the Bethe-Salpeter Equation [2]. Different contributions will be linked to physical effects that are observed in various applications [3] including simple bulk semiconductors and insulators, but also transition metal oxides, nanostructures, or disordered systems. Some recent developments will also be presented.

[1] E. Runge and E. K. U. Gross, Phys. Rev. Lett. 52, 997 (1984).

[2] G. Onida, L. Reining, and A. Rubio, Reviews of Modern Physics 74, 601 (2002).

[3] See e.g. F. Bruneval, S. Botti, L. Reining, Phys. Rev. Lett. 94, 219701 (2005); H.-C. Weissker et al., Phys. Rev. Lett. 97, 237602 (2006).

TT 5.2 Mon 14:30 H18

Determining the ordered orbital and spin momentum as well as orbital order with the use of sum-rules in x-ray resonant scattering. — •M. W. Haverkort, C. Schüssler-Langeheine, T. Willers, and L. H. Tjeng — II. Physikalisches Institut, Universität zu Köln, Zülpicher Str. 77, 50937 Köln, Germany

Sum-rules in x-ray circular dichroism relating the integrated intensity of the x-ray absorption spectra taken with different circular polarizations to the total spin and orbital momentum are well known. Less known, but derived on the same principles, are sum rules for linear dichroism relating the absorption intensity with different linear polarizations to the orbital occupation. We extended these sum-rules, known for x-ray absorption spectroscopy, to the closely related method of resonant x-ray scattering, and show how to use this method to obtain quantitative information on charge, orbital, orbital momentum and on spin ordering even in antiferromagnetic systems. Supported by the DFG through SFB 608.

TT 5.3 Mon 14:45 H18

Kinks in the dispersion of strongly correlated electrons — •Marcus Kollar[1], Krzysztof Byczuk[1,2], Karsten Held[3], Yi-Feng Yang[3], Igor Nekrasov[4], Thomas Pruschke[5], and Dieter Vollhardt[1] — [1]Theoretical Physics III, Center for Electronic Correlations and Magnetism, Institute for Physics, University of Augsburg — [2]Institute of Theoretical Physics, Warsaw University — [3]Max-Planck Institute for Solid State Research, Stuttgart — [4]Institute for Electrophysics, Russian Academy of Sciences, Ekaterinburg — [5]Institute for Theoretical Physics, University of Göttingen

The properties of condensed matter are determined by single-particle and collective excitations and their interactions. The coupling of two excitations may lead to abrupt changes (kinks) in the slope of the dispersion. Such kinks thus carry important information about interactions in a many-body system are of great interest, e.g., in the high-temperature superconductors. We report a novel, purely electronic mechanism yielding kinks in the electron dispersions [1]. It applies to strongly correlated metals whose spectral function shows well separated Hubbard subbands and central peak as, for example, in transition metal-oxides. The position of the kinks and the energy range of validity of Fermi-liquid (FL) theory is determined solely by the FL renormalization factor and the bare, uncorrelated band structure. ARPES experiments at binding energies outside the FL regime can thus provide new, previously unexpected information about strongly correlated electronic systems.

[1] K. Byczuk *et al.*, Preprint cond-mat/0609594.

TT 5.4 Mon 15:00 H18

Dynamical vertex approximation — a step beyond dynamical mean field theory — •Alessandro Toschi[1], Andrey Katanin[1,2], and Karsten Held[1] — [1]Max-Planck-Institut für Festkörperforschung, 70569 Stuttgart, Germany — [2]Institute of Metal Physics, 620219 Ekaterinburg, Russia

We have developed a new diagrammatic approach, coined "Dynamical Vertex Approximation" (DΓA), with the aim of going beyond dynamical mean field theory for strongly correlated systems, by including the effects of long-range spatial correlations. Without resorting to any finite-size cluster scheme, DΓA allows us to compute momentum dependent self-energies (and spectra), whose expressions are diagrammatically constructed starting from the two-particle irreducible local vertex. Therefore, DΓA naturally applies for studying effects of magnetic fluctuations with large correlation length in strongly correlated systems, such as the Hubbard model. Specifically, we analyze the interplay between antiferromagnetic fluctuations and the Mott metal-insulator transition in three dimensions and the formation of a pseudogap in two dimensions. The diagrammatic nature of DΓA, moreover, should allow for a generalization to the more realistic case of multi-band Hamiltonians.

TT 5.5 Mon 15:15 H18

Nature and order of orbital-selective Mott transitions — •Nils Blümer[1] and Krunoslav Požgajčić[2] — [1]Institut für Physik, Johannes Gutenberg-Universität, 55099 Mainz — [2]Institut für Theoretische Physik, J.W. Goethe-Universität, 60438 Frankfurt

Motivated by experiments on $Ca_{2-x}Sr_xRuO_4$, numerous theoretical studies have recently explored the possible occurence of orbital-selective Mott transitions (OSMTs) in multi-band Hubbard models with orbital-dependent hopping amplitudes. By now, consensus has been reached that (within dynamical mean-field theory, DMFT) a sequence of two orbital-selective transitions occurs generically in the two-band case – even in the case of Ising-type Hund rule couplings. However, the precise nature and thermodynamic order of each of these transitions (which may be different for $T>0$ and $T=0$) have remained controversial.

In order to address these issues, we directly compute first derivatives of the free energy within DMFT using quantum Monte Carlo (QMC) simulations at $T>0$ and selfenergy functional theory (SFT) at $T=0$. High precision is achieved in QMC by using analytic high-frequency corrections and in SFT by including multiple bath sites per orbital, respectively, and checked by comparisons of SFT data with $T \to 0$ extrapolated QMC results.

TT 5.6 Mon 15:30 H18

Ab-initio wavefunction-based methods for solids: correlation corrections to the band structure of oxide compounds — •Liviu Hozoi, Uwe Birkenheuer, and Peter Fulde — Max-Planck-Institut fuer Physik komplexer Systeme, 01187 Dresden

We apply ab-initio wavefunction-based methods to the study of correlation effects on the band structure of oxide compounds. We choose MgO as a prototype closed-shell system. As a zeroth-order approximation, we compute first the Hartree-Fock (HF) bands and the (localized) Wannier orbitals associated with these. The HF data for the infinite crystal is transferred then to a quantum chemical program and used as input for the construction of embedded clusters. Correlation effects on the fundamental band gap and on band widths are computed by using a quasiparticle picture and a local Hamiltonian approach. For the (N-1)/(N+1) valence and conduction band states, we found that relaxation and polarization effects associated with the on-site and nearest-neighbor ligand electron shells account for 40% of the difference between the HF and experimental gaps. Long-range polarization effects bring also large corrections. Within the approximation of a dielectric continuum, these corrections amount to 50% of the difference between the HF and experimental gap values. Whereas correlation effects are important for estimating band gaps, we found that they produce only minor changes on the HF band widths, at least in this material. The results show that our approach, based on a transparent formalism and well-controlled approximations, is able to provide a good understanding of the major effects that determine the electronic band structure.

15 min. break

Invited Talk TT 5.7 Mon 16:00 H18

Electronic Correlations in Electron-Transfer Systems — •Ralf Bulla[1], Sabine Tornow[1], and Frithjof Anders[2] — [1]Theoretische Physik III, Elektronische Korrelationen und Magnetismus, Institut für Physik, Universität Augsburg — [2]Fachbereich 1, Universität Bremen

Electron transfer processes play an important role in a variety of physical, chemical, and biological systems. Already the transfer of a single electron from the donor to the acceptor can be viewed as a complicated many-body problem, due to the coupling of the electron to the infinitely many environmental degrees of freedom, usually described as a bosonic bath. Here we focus on the quantum mechanical modelling of *two*-electron transfer processes and the influence of the Coulomb interaction between the electrons. It turns out that electronic correlations significantly influence the dynamics of the electron transfer process. We identify situations under which concerted transfer of the two electrons occurs, in contrast to a stepwise single-electron transfer. Calculations are performed using the non-perturbative numerical renormalization group approach for both equilibrium and non-equilibrium properties.

TT 5.8 Mon 16:30 H18

Charge transfer through DNA and peptides: The role of electron correlations — •Sabine Tornow[1], F. Anders[2], and R. Bulla[1] — [1]Theoretical Physics III,Center for Electronic Correlations and Magnetism,University of Augsburg — [2]Institute of theoretical physics,University of Bremen

In nature charges are transferred trough proteins or DNA over large distances. To describe the real time dynamics of the charges we consider a dissipative extended Hubbard model. The environment is modelled similar as in a spin boson model. In the nuclear tunnelling regime we calculate the time dependent populations with the time-dependent Numerical Renormalization Group. We found a considerable difference between single and multiple charge dynamics.

TT 5.9 Mon 16:45 H18

Competition of Pomeranchuk instability and superconductivity — •hiroyuki yamase and walter metzner — Max-Planck-Institute for Solid State Research, Heisenbergstrasse 1, 70569 Stuttgart, Germany

We analyze a mean-field model of electrons on a square lattice with two types of interaction: forward scattering favoring d-wave Fermi surface symmetry breaking (Pomeranchuk instability) and a BCS interaction driving d-wave superconductivity. Tuning the interaction parameters a rich variety of phase diagrams is obtained. If the BCS interaction is not too strong, Fermi surface symmetry breaking is obtained around van Hove filling, and coexists with superconductivity at low temperatures. In the presence of a paring gap it is easier to realize Fermi surface symmetry breaking via a continuous phase transition at low temperatures than without. For a relatively strong BCS interaction, Fermi surface symmetry breaking can be limited to intermediate temperatures, or can be suppressed completely by pairing.

TT 5.10 Mon 17:00 H18

Nonequilibrium functional renormalization group for interacting fermionic quantum systems — •Severin Jakobs[1], Volker Meden[2], and Herbert Schoeller[1] — [1]Institut für Theoretische Physik A, RWTH Aachen, Germany — [2]Institut für Theoretische Physik, Universität Göttingen, Germany

We extend the functional renormalization group to the treatment of fermionic quantum systems within Keldysh formalism, providing a unified approach to equilibrium and nonequilibrium situations. To this end we introduce an imaginary frequency cut-off to the relevant fermi functions. In case of nonequilibrium, the flow parameter is furnished with additional real components corresponding to the different chemical potentials involved. Applying our method to nonlinear transport through an interacting quantum wire with two contact barriers, we find that nonequilibrium induces a change of the scaling exponents.

TT 5.11 Mon 17:15 H18

Konkurrenz von Supraleitung und Ladungsordnung im zweidimensionalen Holstein-Modell — •Steffen Sykora, Arnd Hübsch und Klaus Becker — Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany

Wir untersuchen die gegenseitige Beeinflussung von Supraleitung und Ladungsordnung im zweidimensionalen Holstein-Modell mit Hilfe einer neuartigen projektiven Renormierungsmethode (PRM). Ausgangspunkt ist ein effektiver Hamiltonoperator, der Ordnungsparameter für eine mögliche Ladungsordnung und für Supraleitung enthält. Durch schrittweises Eliminieren der Elektron-Phonon-Wechselwirkung werden die Ordnungsparameter und auch die elektronischen und phononischen Anregungsenergien renormiert. Es zeigt sich, dass bei hinreichend starker Kopplung ein Übergang von einer supraleitenden zu einer ladungsgeordneten Phase auftritt.

TT 5.12 Mon 17:30 H18

Constructing an exact CSL Hamiltonian — •Ronny Thomale[1], Darrell Schroeter[2], Eliot Kapit[3], and Martin Greiter[1] — [1]Institut für Theorie der Kondensierten Materie, D 76128 Karlsruhe — [2]Department of Physics, Occidental College, Los Angeles, CA — [3]Department of Physics, University of Chicago, Chicago, IL

We construct a Hamiltonian that singles out the chiral spin liquid on a square lattice with periodic boundary conditions as the exact and, apart from the two-fold topological degeneracy, unique ground state. The model provides a framework to study spinon excitations and the fractional statistics they obey in two dimensions, an issue of interest to the fields of topological quantum phases, high-T_c superconductivity, and quantum computing.

TT 5.13 Mon 17:45 H18

Magnetic phases of the t-J model at low doping — •Juergen Falb, Marcello Barbosa da Silva Neto, and Alejandro Muramatsu — Institut für Theoretische Physik III, Universitaet Stuttgart, D-70550 Stuttgart, Germany

Based on the method of Dirac quantization for constrained systems, we set up a path integral for the t-J model. Spin degrees of freedom result in a unimodular vector field while dopant holes are spin 1/2 fermions. The constraint against double occupancy can be solved exactly by choosing spin quantization axes of the dopant holes that follow the local direction of the spins. Assuming a staggered spin field leads to staggered spinless fermions. A gradient expansion of the t-t'-t"-J model in the low doping limit leads to a CP^1 model with a coupling to the gauge fields different from 1. The possible magnetic phases in parameter space will be discussed.

TT 6: Nanoelectronics III - Molecular Electronics

Time: Monday 14:00–17:00 Location: H19

TT 6.1 Mon 14:00 H19

Electron transport through organic molecules and the influence of adsorbates on the conductance of aluminium contacts — •F. Pauly[1,2], S. Wohlthat[1,2], J. Viljas[1,2], M. Häfner[1,2], J.C. Cuevas[1,2,3], and Gerd Schön[1,2] — [1]Institut für Theoretische Festkörperphysik, Universität Karlsruhe, D-76128 Karlsruhe — [2]Institut für Nanotechnologie, Forschungszentrum Karlsruhe, D-76021 Karlsruhe — [3]Departamento de Física Teórica de la Materia Condensada C-V, Universidad Autónoma de Madrid, E-28049 Madrid

In the first part of this talk we will analyze the electrical conductance properties of a series of organic molecules. This series comprises molecules with different numbers of phenyl rings and modified side groups [1]. For these oligophenylenes we investigate the changes in the conductance due to both varied molecule lengths and different bonding positions within our newly developed DFT transport program [2,3]. As a second application of our method we study the transport properties of atomic-sized aluminium contacts in the presence of oxygen molecules, namely O, O_2, and O_3. In particlar we analyze the evolution of the transport characteristics for increasing electrode distances, simulating the opening of a break junction [4].

[1] M. Elbing, PhD Thesis, FZ Karlsruhe (2005); [2] F. Pauly, PhD Thesis, Universität Karlsruhe (2007); [3] F. Pauly, J.K. Viljas, U. Huniar, M. Häfner, J.C. Cuevas, and Gerd Schön, (in preparation); [4] S. Wohlthat, Diploma thesis, Universität Karlsruhe (2006)

TT 6.2 Mon 14:15 H19

Nonequilibrium resonant spectroscopy of molecular vibrons — •Dmitry Ryndyk and Gianaurelio Cuniberti — Institut für Theoretische Physik, Universität Regensburg, 93040 Regensburg

Quantum transport through single molecules is essentially affected by molecular vibrations. We investigate the behavior of the molecular transistor with intermediate electron-vibron coupling and arbitrary coupling to the leads. We have developed a theory which allows to explore this regime via the nonequilibrium Green function formalism parallel to the widely used master equation technique. The problem is motivated by recent scanning tunneling spectroscopy experiments. We show that the nonequilibrium resonant spectroscopy is able to determine the energies of molecular orbitals and the spectrum of molecular vibrations. Our results are relevant to STS experiments, and demonstrate the importance of the systematic and self-consistent investigation of the effects of the vibronic dynamics onto the transport through single molecules.

TT 6.3 Mon 14:30 H19

Influence of vibrational modes on the electronic properties of DNA — •Benjamin Schmidt[1,2], Matthias Hellter[2], Gerd Schön[1,2], Evgeni Starikov[2], and Wolfgang Wenzel[2] — [1]Institut für Theoretische Festkörperphysik, Universität Karlsruhe, 76128 Karlsruhe, Germany — [2]Forschungszentrum Karlsruhe, Institut für Nanotechnologie, Postfach 3640, 76021 Karlsruhe, Germany

We investigate the electron (hole) transport through short double-stranded DNA wires in which the electrons are strongly coupled to the specific vibrational modes (vibrons) of the DNA. We analyze the problem starting from a tight-binding model of DNA, with parameters derived from ab-initio calculations, and describe the dissipative transport by equation-of-motion techniques. For homogeneous DNA sequences like Poly- (Guanine-Cytosine) we find the transport to be quasi-ballistic with an effective density of states which is modified by the electron-vibron coupling. At low temperatures the linear conductance is strongly enhanced, but above the 'semiconducting' gap it is affected much less. In contrast, for inhomogeneous ('natural') sequences almost all states are strongly localized, and transport is dominated by dissipative processes. In this case, a non-local electron-vibron coupling influences the conductance in a qualitative and sequence-dependent way.

TT 6.4 Mon 14:45 H19

Influence of chopped laser light onto the electronic transport through atomic-sized contacts — •Daniel Guhr, Dennis Rettinger, Johannes Boneberg, Artur Erbe, Paul Leiderer, and Elke Scheer — University of Konstanz, Germany

In our experiment we investigate the influence of laser irradiation onto the electrical conductance of gold nanocontacts established with the mechanically controllable breakjunction technique. We concentrate on the study of reversible conductance changes which can be as high as 200%. In our measurements we have varied the intensity, the polarisation and the wavelength of the laser beam in the visible range of the spectrum as well as its position on the sample. Under most conditions an enhancement of conductance is observed. We discuss several physical mechanisms which might contribute to the observed effect including thermal expansion, rectification of nonlinear current-voltage characteristics by the ac electric field of the laser light [1] and photon-assisted transport (PAT) [2]. From the analysis of our data we conclude that PAT is the dominating effect in out experiment while small contributions from thermal expansion cannot be excluded [3].

[1] R. Möller,J. Vac. Sci. Technol. B9, 506-509, 1991
[2] J.K. Viljas and J.C. Cuevas, cond-mat/0607505
[3] D. Guhr et al., cond-mat/0612117

TT 6.5 Mon 15:00 H19

Role of electronic structure in photo-assisted transport through atomic-sized contacts — •Janne Viljas[1,2] and Juan Carlos Cuevas[1,2,3] — [1]Institut für Theoretische Festkörperphysik, Universität Karlsruhe, D-76128 Karlsruhe — [2]Forschungszentrum Karlsruhe, Institut für Nanotechnologie, D-76021 Karlsruhe — [3]Departamento de Física Teórica de la Materia Condensada C-V, Universidad Autónoma de Madrid, E-28049 Madrid, Spain

We study theoretically quantum transport through laser-irradiated metallic atomic-sized contacts [1]. The radiation is treated classically, assuming its effect to be the generation of an ac voltage over the contact. We derive an expression for the dc current and compute the linear conductance in ideal one-atom thick contact geometries as a function of the ac frequency, concentrating on the role played by electronic structure. In particular, we present results for three metals (Al, Pt, and Au), the electronic structures of which are described with an *spd* tight-binding parametrization. Depending on the frequency and the metal, the ac voltage can either enhance or reduce the conductance. This can be intuitively understood in terms of the energy dependence of the transmission in the absence of radiation. Recent experiments [2] on laser-irradiated gold contacts support the view that photo-assisted processes may play an important role in the transport through such systems.

[1] J. K. Viljas and J. C. Cuevas, cond-mat/0607505.
[2] D. Guhr, D. Rettinger, J. Boneberg, A. Erbe, P. Leiderer, and E. Scheer, cond-mat/0612117 and this conference.

15 min. break

TT 6.6 Mon 15:30 H19

Electron transport in bundles of metallic single-walled carbon nanotubes — •Ines Barbara Klugius[1], Christoph Wolfgang Marquardt[1], Frank Hennrich[1], Hilbert v. Löhneysen[2,3], and Ralph Krupke[1] — [1]Forschungszentrum Karlsruhe, Institut für Nanotechnologie, 76021 Karlsruhe, Germany — [2]Universität Karlsruhe, Physikalisches Institut, 76128 Karlsruhe, Germany — [3]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, 76021 Karlsruhe, Germany

Electron transport in individual metallic single-walled carbon nanotubes (SWNT) has been described within a Luttinger liquid model (LL) which can explain the power law behaviour found in the temperature dependent conductance, as well as in the voltage dependent differential conductance. In heterogeneous bundles of SWNTs, that are composites of metallic and semiconducting tubes, similar power law behaviour has been observed.

During the fabrication of carbon nanotubes both metallic and semicon-ducting ones are produced. Using dielectrophoresis as a method to separate these types, we are able to prepare samples of bundles of exclusively metallic SWNTs. In this configuration, the SWNTs are still surrounded by the surfactant that is necessary for the separation process. On such samples we measure the transport characteristics and anticipate a deviation from the LL behaviour due to enhanced intertube coupling. To enforce the coupling, we anneal the samples assuming that in this manner, the amount of surfactant inbetween the tubes is abated and the tube-tube distance is reduced.

TT 6.7 Mon 15:45 H19

Coulomb repulsion effects in driven electron transport through molecules — •Franz J. Kaiser, Peter Hänggi, and Sigmund Kohler — Institut für Physik, Universität Augsburg, 86135 Augsburg

We investigate the influence of strong Coulomb repulsion on the current through molecular wires. The molecule is described by a tight-binding model whose first and last site is coupled to a respective lead. The leads are eliminated within a perturbation theory yielding a master equation for the wire. In the non-driven case, we explore the transport properties of a bridged molecular wire, where the current decays exponentially as a function of the wire length [1]. For studying conductors driven by external electromagnetic fields, we decompose the reduced density operator into a Floquet basis. This enables an efficient treatment of the time-dependent transport problem. For the electronic excitations in bridged molecular wires, we find that strong Coulomb repulsion significantly sharpens resonance peaks which broaden again with increasing temperature [2].

[1] F.J. Kaiser, M. Strass, S. Kohler, and P.Hänggi, Chem. Phys. **322**, 193 (2006)
[2] F.J. Kaiser, P.Hänggi, and S. Kohler, Eur. Phys. J. (in press); cond-mat/0606457

TT 6.8 Mon 16:00 H19

Multishell Coulomb blockade in multiwall carbon nanotubes — •Emiliano Pallecchi[1], Shidong Wang[1], Csilla Miko[2], Laszlo Forro[2], Milena Grifoni[1], and Christoph Strunk[1] — [1]University of Regensburg, D-93040 Regensburg, Germany — [2]FBS Swiss Federal

Institute of Technology (EPFL), CH-1015 Lausanne, Switzerland

We performed low temperature measurements of magnetoconductance and non linear conductance for multiwall carbon nanotubes. Signatures of phase coherent diffusive transport are the weak localization dip and universal conductance fluctuations. At very low temperature, "anomalous" Coulomb blockade is observed: we find a superposition of several diamonds patterns in the Vsd-Ugate plane with different size. The stability diagrams are more regular than in previous studies, but qualitatively different from that observed in single wall carbon nanotubes. We attribute this behavior to the effect of the inner shells on the charging process and propose a model where the nanotube is represented by two quantum dots in parallel.

TT 6.9 Mon 16:15 H19

One dimensional organometallic wires: electronic structure and transport properties — •Volodymyr Maslyuk[1], Alexei Bagrets[2], Mads Brandbyge[3], and Ingrid Mertig[1] — [1]Martin-Luther-Universität Halle-Wittenberg, Physical Department, Halle, Germany — [2]Institute of Nanotechnology, Forschungszentrum Karlsruhe, Germany — [3]NanoDTU, MIC-Department of Micro and Nanotechnology, Technical University of Denmark, Lyngby, Denmark

During the last years, organometallic systems have attracted increasing attention. The small size of the molecules and the spin degree of freedom allow us to consider them as independent logic units and think about new electronic devices with unforeseen properties. Here, we focus on multi-decker metal-cyclopentadienyl Met(C5H5) and metal-benzene Met(C6H6) molecules. Recently, we have predicted that a one-dimensional vanadium-benzene wire is a half-metallic ferromagnet and finite V(C6H6) clusters coupled to magnetic leads are working as spin-filter [1]. Moreover, our bias dependence calculations show conservation of the half-metallic properties in a wide voltage window. Using density functional theory and the non-equilibrium Green's-function method, implemented in the TranSIESTA code [2], we have investigated the electronic and transport properties of 1D organometallic wires coupled with Co(100) electrodes. We have also investigated the electron transport through the molecules in the case of antiparallel magnetic configuration of the electrodes and predict an impressive magnetoresistance effect. [1] V. Maslyuk et al., Phys. Rev. Lett 97, 097201 (2006). [2] M. Brandbyge et al. Phys. Rev. B 65, 165401 (2002).

TT 6.10 Mon 16:30 H19

Cotunneling and non-equilibrium magnetization in magnetic molecular monolayers — •Florian Elste[1] and Carsten Timm[2] — [1]Institut für Theoretische Physik, Freie Universität Berlin, Germany — [2]Department of Physics and Astronomy, University of Kansas, USA

We study the interplay of electronic transport through monolayers of magnetic molecules and their non-equilibrium magnetic moment. A master-equation approach going beyond the sequential-tunneling approximation is applied to study the Coulomb-blockade regime. While the current is very small in this case, the magnetization can be switched by an amount of the order of the saturation magnetization by a small change of bias voltage, and without causing the flow of a large current. Inelastic cotunneling processes manifest themselves as steps in the differential conductance, which are accompanied by much larger changes in the magnetization. In addition, the magnetization in the Coulomb-blockade regime exhibits strong signatures of sequential-tunneling processes de-exciting molecular states populated by inelastic cotunneling. We also consider the case of a magnetic single-molecule transistor, finding that cotunneling processes lead to the occurrence of magnetic sidebands below the Coulomb-blockade threshold. In the context of spintronics applications, we investigate effects of additional spin relaxation. Our results show that sufficiently fast spin relaxation washes out the fine structure in the differential conductance and in the magnetization. At the same time, fast spin relaxation, while in general undesirable, can lead to a highly-polarized current in the presence of a magnetic field.

TT 6.11 Mon 16:45 H19

Der Einfluß von Berry-Phasen auf die Leitfähigkeit eines einzelnen Jahn-Teller Moleküls — •Maximilian G Schultz, Tamara S Nunner und Felix von Oppen — Institut f. Theoretische Physik, FU Berlin, Arnimallee 14, 14195 Berlin

Wir studieren die elektronischen Transporteigenschaften eines oktaedrischen Moleküls im Grenzfall schwacher Kopplung an zwei metallische Elektroden. Die Berry-Phase des $E \otimes e$ Jahn-Teller Effekts impliziert eine nichttriviale Auswahlregel in der Tunnelmatrix; die Jahn-Teller Verzerrung selbst induziert starke Verschiebungen im Spektrum der molekularen Schwingungen. In der Mastergleichung, mit der elektronischer Transport durch das System beschrieben wird, entstehen dadurch absorbierende Zustände, die den stationären Strom durch die Elektroden unterdrücken. Dies führt zu einer negativen differentiellen Leitfähigkeit und einer starken Asymmetrie im dI/dV Diagramm bezüglich der Gate-Spannung.

TT 7: Quantum Coherence and Quantum Information Systems II

Time: Monday 14:00–16:00 Location: H20

TT 7.1 Mon 14:00 H20

Use of dynamical coupling for improved quantum state transfer — •Andriy Lyakhov and Christoph Bruder — University of Basel, Switzerland

Efficient short-distance quantum state transfer is an important problem in quantum information processing. One of the most promising solutions is to use chains constructed from qubits that are statically coupled to each other [1]. Here, we propose a method to improve quantum state transfer in such transmission lines. The idea is to localize the information on the last qubit of a transmission line by dynamically varying the coupling constants between the first and the last pair of qubits. We also show that this method increases the fidelity of the state transfer and that this effect is stable to static disorder in the coupling constants and dynamical fluctuations in the coupling/decoupling functions [2].

[1] S. Bose, Phys. Rev. Lett. 91 207901 (2003)
[2] A. O. Lyakhov and C. Bruder, Phys. Rev. B 74, 235303 (2006)

TT 7.2 Mon 14:15 H20

A 2D array of Cooper pair boxes as a candidate for a protected qubit — •Jörg-Hendrik Bach, Alexander Shnirman, and Gerd Schön — Institut für theoretische Festkörperphysik, Universität Karlsruhe, 76131-Karlsruhe

We consider a 2-dimensional array of double-island Cooper pair boxes as a candidate for a protected qubit. Two types of couplings are implemented in the array. These are inductive nearest-neighbour couplings along the array's rows and capacitive nearest-neighbour couplings between the array's columns. Projected onto the doubly degenerate ground states of the Cooper pair boxes the two couplings do not commute. Thus the system reduces effectively to an array of spin-1/2 particles with non-commuting row- and column couplings. This reminds of the system proposed by Doucot et al. [Phys. Rev. B 71, 024505 (2005)] in the context of protected quantum computing. Similarities and differences to this system are pointed out; furthermore, the influence of the third level of the Cooper pair box is investigated.

TT 7.3 Mon 14:30 H20

Macroscopic quantum tunneling in globally coupled series arrays of Josephson junctions — •Mikhail V. Fistul — Theoretische Physik III, Ruhr-Universität Bochum, D-44801, Bochum Germany

A quantitative analysis of an escape rate for switching from the superconducting state to a resistive one in series arrays of globally coupled Josephson junctions will be presented. A global coupling is provided by an external shunting impedance. Such an impedance can strongly suppress both the crossover temperature from the thermal fluctuation to quantum regimes, and the macroscopic quantum tunneling (MQT) in short Josephson junction series arrays [1]. However, in large series arrays we obtain an enhancement of the crossover temperature, and a giant increase of the MQT escape rate [2]. The effect is explained by excitation of a *spatial-temporal charge instanton* distributed over a whole structure. The model gives a possible explanation of recently published experimental results on an enhancement of the MQT in single crystals of high-T_c superconductors [3].

[1]. D. Esteve, M. H. Devoret, and J. M. Martinis, Phys. Rev. B **34**, 158 (1986).
[2]. M. V. Fistul, cond-mat/0608456.
[3]. X. Y. Jin, J. Lisenfeld, Y. Koval, A. Lukashenko, A. V. Ustinov, and P. Müller, Phys. Rev. Lett. **96**, 177003 (2006).

TT 7.4 Mon 14:45 H20

Observation of Macroscopic Quantum Behavior in π Josephson Junctions with Ferromagnetic Interlayer — •Karl Madek[1], Martin Weides[2], Sven Beutner[1], Achim Marx[1], Hermann Kohlstedt[2], and Rudolf Gross[1] — [1]Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, D-85748 Garching — [2]Institut für Festkörperforschung und CNI, Forschungszentrum Jülich, D-52425 Jülich

Superconducting circuits are particularly interesting for the implementation of quantum information systems. For the realization of superconducting flux qubits the use of π-Josephson junctions is promising, since it would allow the design of qubits in a quiet configuration. Such π-junctions have been successfully realized using Josephson junctions with an additional thin ferromagnetic interlayer. However, nothing is known so far on the quantum behavior of these junctions.

We performed measurements of both the macroscopic quantum tunneling of the phase variable and the level quantization in $Nb/AlO_x/CuNi/Nb$ π-Josephson junctions. Escape rate measurements show a crossover from the thermally activated regime, in which the phase variable escapes by thermal activation from a local minimum of the potential well, to the quantum regime, where macroscopic quantum tunneling dominates. Microwave spectroscopy experiments give direct evidence for energy level quantization. Both quantized energy levels in the tilt washboard potential as well as multi-photon transitions between the levels have been observed.

This work was supported by the DFG through SFB 631.

TT 7.5 Mon 15:00 H20

Spin-boson dynamics: A unified approach from weak to strong coupling — •Francesco Nesi[1], Milena Grifoni[1], Elisabetta Paladino[2], and Michael Thorwart[3] — [1]Theoretische Physik, Universität Regensburg, Germany — [2]Dipartimento di Metodologie Chimiche e Fisiche, Università di Catania, 95128 Italy and MATIS-CNR-INFM, Catania Italy — [3]Institut für Theoretische Physik, Heinrich-Heine-Universität Düsseldorf, 40225 Germany

We present a novel approximation scheme to describe in a unified way the influence of a harmonic bath on the dynamics of a two-level particle over the *whole* regime of temperatures and coupling to the environment, and for a wide class of bath spectral densities. Starting from the exact path-integral solution for the two-level system density matrix, effective intra-blip correlations are fully included, while inter-blip and blip-sojourns interactions are considered up to first order. In the proper regime of parameters, results of conventional perturbative approximation schemes are recovered and an excellent agreement with ab-initio path-integral results is found.

→ http://arxiv.org/abs/cond-mat/0612396

TT 7.6 Mon 15:15 H20

Quantum Telegraph Noise — •Benjamin Abel and Florian Marquardt — Physics Department, Center for NanoScience, and Arnold Sommerfeld Center for Theoretical Physics, München

We analyze the effect of quantum telegraph noise, produced by a single electronic defect level, on the decoherence of a charge qubit. In contrast to earlier works, [1], [2], [3], we describe the full time-evolution of the coherence factor even at short and intermediate times. In striking contrast to the well-known case of decoherence by a bath of harmonic oscillators, the coherence factor displays oscillations as a function of time and other parameters. We analyze these in detail using a numerical evaluation of the exact solution for the density matrix of the qubit.

[1] Y. Makhlin, A. Shnirman, Phys. Rev. Lett. 92, 178301 (2004).
[2] Alex Grishin, Igor V. Yurkevich, and Igor V. Lerner, Phys. Rev. B 72, 060509(R) (2005)
[3] Galperin, Y. M., Altshuler, B. L., and Shantsev, D. V., Phys. Rev. Lett. 96 097009 (2006)

TT 7.7 Mon 15:30 H20

Spin Dynamics and Hyperfine Interaction in Quantum Dots — •Daniel Klauser, William Anthony Coish, and Daniel Loss — Departement of Physics and Astronomy, University of Basel, Klingelbergstrasse 82, CH-4056 Basel, Switzerland

The idea of using the spin of electrons confined to quantum dots for quantum information processing [1], has triggered research to understand the effect of hyperfine interaction on the evolution of electron spins in (double) quantum dots. The hyperfine interaction between the electron spin and the surrounding nuclear spins leads to decoherence of the electron spin state, but also allows to gain information on the nuclear spins through measurement of the electron spin evolution [2]. We discuss recent experimental and theoretical progress in controlling electron spin dynamics under hyperfine interaction.

[1] D. Loss and D. P. DiVincenzo, Phys. Rev. A 57, 120 (1998).
[2] D. Klauser, W. A. Coish, D. Loss, Phys. Rev. B 73, 205302 (2006).

TT 7.8 Mon 15:45 H20

Spin qubits with electrically gated polyoxometalates — •Jörg Lehmann[1], Alejandro Gaita-Ariño[2], Eugenio Coronado[2], and Daniel Loss[1] — [1]Departement für Physik und Astronomie, Universität Basel, Schweiz — [2]Institute of Molecular Science, Universitat de Valencia, Spain

We present a scheme for the implementation of a fundamental quantum gate, the so-called square-root-of-swap operation, in electrically gated polyoxometalates. The specific molecules we consider comprise three parts: two localized spins 1/2 forming the qubits and a central core, which couples the two spins via an indirect exchange mechanism. By charging and decharging the central core the exchange interaction between the two qubits can be controlled and the square-root-of-swap gate can be realized. Based on a Bloch-Redfield description of the charging dynamics of the molecule coupled to metallic leads we calculate the gate fidelity. Using parameters obtained from an ab-initio description of the molecule, we show that fidelities of up to 99% can be achieved.

TT 8: Superconductivity - Poster Session

Time: Monday 14:00–17:45 Location: Poster A

TT 8.1 Mon 14:00 Poster A

Analysis and Optimization of Oxide Buffer Layers Related to YBCO Films Deposited by CSD and MOCVD on Biaxially Textured NiW Substrates — •Elmiloudi Elmechaouri, Burckhard Mönter, and Martin Hoffmann — Bergische Universität Wuppertal Gaußstraße 20, 42119 Wuppertal

The studies based on epitaxial buffer layers of CeO_2 and Yttria-stabilised ZrO_2 (YSZ) having been deposited on biaxially textured nickel substrates using thermal reactive evaporation and rf sputtering in continuous deposition processes in reel-to-reel systems. Starting from the well known architecture of CeO_2/ YSZ/ CeO_2 the thickness of the different buffer layers was varied. Misorientation, porosity and roughness was analyzed and optimized for YBCO deposition by MOCVD und CSD. The grain morphology and the behavior of the grain boundary networks in YBCO coated conductors have been shown to depend on both the YBCO deposition method and the buffers layer. The possibility of using only one and two buffers layer and conductive layers of perovskite type was studied. X-ray-diffraction, SEM and TEM have been used to investigate the microstructure of both the buffer layers and the YBCO films. Optimal growth conditions of YBCO for the different buffer layers have been determined. YBCO films were deposited by CSD, MOCVD and for comparison by high pressure dc sputtering, resulting on $CeO_2/YSZ/CeO_2$ buffered substrates Jc values higher than 2 MA/cm^2. The resulting superconducting properties were measured by inductive characterization and by Hall probe measurements of the Magnetic field due to induced magnetization currents.

TT 8.2 Mon 14:00 Poster A

TEM analysis of biaxially textured $La_2Zr_2O_7$ thin films by the Moiré technique — •Leopoldo Molina[1], Kerstin Knoth[2], Bernhard Holzapfel[2], and Oliver Eibl[1] — [1]Institute of Applied Physics, University of Tübingen, Auf der Morgenstelle 10, D-72076, Tübingen, Germany — [2]IFW Dresden, P.O.Box 270116, D-01171 Dresden, Germany

Chemically deposited $La_2Zr_2O_7$(LZO) buffer layers on biaxially textured nickel tungsten substrates for $YBa_2Cu_3O_{7-\delta}$(YBCO) coated conductor technology have been investigated by transmission electron microscopy (TEM). The biaxially textured LZO thin films were 80 nm thick and were annealed at T = 900°C. The samples were then prepared in plan-view for TEM investigations. The Ni grain size is about 40 μm, whereas the grain size of the LZO films is about 100 nm. The Moiré fringe contrast magnifies the misorientation of the LZO grains with respect to the underlying Ni grain by about a factor of 10. Imaging of small rotations ($\leq 3°$) of the LZO grains with respect to the underlying nickel tungsten grains was possible. Thus, the large misfit of 7.6 % between the LZO film and the nickel tungsten substrate might be additionally compensated by the tilting of the small LZO grains rather than by only introducing misfit dislocations at the substrate-film interface.

TT 8.3 Mon 14:00 Poster A

Ru moment in the magnetically ordered superconductor $RuSr_2GdCu_2O_8$ — •Thomas P. Papageorgiou[1], Eugenio Casini[2], Yuri Skourski[1], Thomas Herrmannsdörfer[1], Jens Freudenberger[3], Hans F. Braun[2], and Jochen Wosnitza[1] — [1]Hochfeld-Magnetlabor Dresden (HLD), Forschungszentrum Dresden-Rossendorf, D-01314 Dresden, Germany — [2]Physikalisches Institut, Universität Bayreuth, D-95440 Bayreuth, Germany — [3]IFW Dresden, Institute for Metallic Materials, D-01171 Dresden, Germany

Magnetization measurements of the superconducting ($T_c \approx 47$ K) and magnetically ordered ($T_M^{Ru} \approx 130$ K) $RuSr_2GdCu_2O_8$ (Ru1212) have been performed in pulsed magnetic fields up to 47 T. The average Ru-moment, determined by using $NbSr_2GdCu_2O_8$ as reference, is 1.8 μ_B suggesting that the investigated sample is in a mixed valence state containing 87% Ru^{5+} (2 μ_B) and 13% Ru^{4+} (0.9 μ_B). This ratio is consistent with an underdoped nature of the superconducting state with a hole concentration in the CuO_2 plane of p $\approx$ 0.065. It is suggested that the magnetic structure of Ru1212 consists of a main antiferromagnetic phase formed by Ru^{5+}ions interrupted by ferromagnetic stripes, where double exchange between Ru^{5+} and Ru^{4+} ions takes place. Different Ru^{5+}/Ru^{4+} ratios, due to different preparation conditions, could explain some of the diverse superconducting and magnetic properties reported in the literature for Ru1212.

TT 8.4 Mon 14:00 Poster A

High-Resolution Specific-Heat data of $YBa_2Cu_3O_x$ up to 400 K — •Christoph Meingast[1], Akira Inaba[2], Thomas Wolf[1], Volker Pankoke[1], Rolf Heid[1], and Klaus-Peter Bohnen[1] — [1]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, D-76021 Karlsruhe, Germany — [2]Research Center for Molecular Thermodynamics, Graduate School of Science, Osaka University, Toyonaka, Osaka 560-0043, Japan

Very accurate (0.1 percent) adiabatic specific heat measurements up to 400 K have been made on $YBa_2Cu_3O_x$ samples with oxygen contents x = 6.7, 6.9 and 7.0. The oxygen deficient samples clearly show an anomaly due to the oxygen ordering above room temperature. In order to analyze this oxygen-ordering contribution, as well as the electronic contribution, in detail, the phonon contribution, obtained by first-principles electronic structure calculations, was subtracted from the data. This subtraction works quite well, which demonstrates the quality of both the measured and calculated heat capacities.

TT 8.5 Mon 14:00 Poster A

Anomalous magnetic field dependence of the superconducting condensation energy in $YBa_2Cu_3O_7$ single crystals — •P. Popovich[1,2], C. Meingast[1], S. Tajima[3], and T. Masui[3] — [1]Forschungszentrum Karlsruhe, Institute for Solid-State Physics, 76021 Karlsruhe, Germany — [2]Fakultät für Physik, Universität Karlsruhe, Germany — [3]ISTEC, Tokyo, Japan

The anisotropic magnetostriction and thermal expansion of untwinned $YBa_2Cu_3O_7$ single crystals have been studied using capacitance dilatometry for $H||c$ along all crystallographic axes. The thermodynamical analysis is possible due to the high crystal quality. The magnetostriction coefficient $\lambda_i = \frac{1}{L_i}\frac{dL_i}{dH}$ (i=a,b,c) is reversible above 55 K, providing important information about the pressure dependencies of the thermodynamical critical field $H_c(T)$.

The magnetic field dependence of the zero-temperature superconducting condensation energy is obtained by using the fact that the length (volume) difference between normal and superconducting states, L_n-L_s, provides a direct measure of the uniaxial pressure (hydrostatic pressure) dependence of the superconducting condensation energy. In conventional BCS superconductors, the superconducting condensation energy, as well as the magnitude of L_n-L_s, decreases monotonically with increasing field due to the increasing density of normal-state vortex cores. We find practically no field dependence of L_n-L_s as T approaches zero, which implies that the superconducting pairing energy is nearly field-independent in magnetic field up to 10 T.

TT 8.6 Mon 14:00 Poster A

Thermal Conductivity of underdoped $YBa_2Cu_3O_y$ — •Robert Schneider[1], Anja Waske[1], Christian Hess[1], Bernd Büchner[1], Vladimir Hinkov[2], and Chengtian Lin[2] — [1]Leibniz-Institute for Solid State and Materials Research, IFW-Dresden, 01171 Dresden, Germany — [2]Max Planck Institute for Solid State Research, Heisenbergstrae 1, D-70569 Stuttgart, Germany

We present experimental results on the thermal conductivity κ of an untwinned, underdoped $YBa_2Cu_3O_y$ monocrystal along the 'a direction' with a critical temperature of T_c = 61 K. We observe a peak at low temperatures as it has been previously found for the optimally doped material, for which it is known that the peak originates from heat transport by electronic quasiparticles. However, unlike for this latter case we do not observe a sharp onset of the peak at T_c but find a continuous increase already below $T \approx 150$ K. This increase becomes steeper at T_c and κ eventually peaks around 30 K. A magnetic field perpendicular to the CuO_2 planes significantly suppresses κ in the superconducting phase.

TT 8.7 Mon 14:00 Poster A

Surface studies of underdoped $YBa_2Cu_3O_{6.6}$ by means of Scanning Tunneling Microscopy — •Grzegorz Urbanik[1,2], Torben Hänke[1], Christian Hess[1], Bernd Büchner[1], Antoni Ciszewski[2], Vladimir Hinkov[3], and Chengtian Lin[3] — [1]Leibniz-Institute for Solid State and Materials Research, IFW-Dresden, 01171 Dresden, Germany — [2]Institute of Experimental Physics, University of Wroclaw, Poland — [3]Max Planck Institute for Solid State Research, Heisenbergstrae 1, D-70569 Stuttgart, Germany

According to the data in the literature, low temperature (< 40 K) cleaving of $YBa_2Cu_3O_{7-\delta}$-single crystals under UHV conditions (in order to get high quality surfaces), leads mainly to either BaO or CuO sheets as the topmost layer. We performed scanning tunneling microscopy and spectroscopy on high quality underdoped $YBa_2Cu_3O_{6.6}$ crystals. We present topographic results and a detailed statistical analysis of the step heights on a micrometer scale. Our data show that the cleaving of this material below 40K is much more complicated than anticipated. We find that the material primarily cleaves in multiples of one unit cell. Fractional step heights are also found, but only in few cases ($\sim$ 5%). The topmost layers often exhibit a high corrugation ($\sim$ 3 Å) which indicates that cleaving takes place at either the CuO chain layer or the Y-layer involving a non-uniform distribution of the layer atoms on the two cleaving planes. Furthermore, scanning tunneling spectroscopy reveals that terraces with a height difference smaller than one unit cell differ significantly in their tunneling conductance.

TT 8.8 Mon 14:00 Poster A

The bulge in the basal plane of cuprate superconductors - evidence for $3a$ singlet hole pair formation — •Jürgen Röhler — Universität zu Köln, 50937 Köln, Germany

In the cuprate superconductors the variaton of the basal lattice parameters upon doping is expected to follow the ubiquitous 1-log$m$ behavior of interatomic distances in systems with varying covalency – a behavior discovered by L. Pauling within his theory of resonant valence bonds. m is the degree of covalency. Detailed crystallographic work from the hole doped cuprates, however, finds the interatomic distances in the CuO_2 planes (plotted as a^2 or ab) concave away from the doping axis, not convex toward it. The resulting bulge in the basal plane area is maximum at optimum doping $n_{opt} \simeq 0.16$, and collapses within the weakly overdoped regime around $n \simeq 0.22$. We connect the bulge with a doping dependent repulsive interaction arising from the higher stability of the resonant (ZR) singlet hole states relative to that of single

nn singlet hole states. Thus ZR singlet hole states tend to suppress double occupations of their oxygen cages, hence suppressing the formation of nonresonant $1a$ (nn) singlet hole pairs. Instead $3a$ singlet hole pairs comprising 4 oxygen cages are favored. Within the concept of a superconducting quantum liquid of valence bonds resonating around among different pairings of atoms the constraint to $3a$ hole pair formation creates a strongly textured liquid with nodes along (π, π) in reciprocal space. We show that in this textured liquid $3a$ singlet hole pairs may propagate dissipationless along the Cu–O directions in the background of antiferromagnetically correlated Cu spins.

TT 8.9 Mon 14:00 Poster A

X-ray absorption spectroscopy study of hole doping on Pb-Bi2201 single crystals — •AHMAD KAMAL ARIFFIN, BEATE MÜLLER, RÜDIGER MITDANK, LENART DUDY, HELMUT DWELK, ALICA KRAPF, CHRISTOPH JANOWITZ, and RECARDO MANZKE — Institut für Physik, Humboldt-Universität zu Berlin, Newtonstr. 15, D-12489 Berlin

X-ray absorption spectroscopy is a reliable technique to evaluate the hole content n_H in polycrystalline oxide-based high temperature superconductors. For single crystals, the same method can be used by taking into consideration the dependency of the absorption on orientation of the polarization vector in the CuO_2-plane. The polarization i.e. angular dependence of the main and satellite peak at the Cu-L_3 edge of $Bi_{2-y}Pb_ySr_{2-x}La_xCuO_{6+\delta}$ (Pb-Bi2201) single crystals was studied by XAS over a wide doping range. The optimum and the underdoped samples show maxima and minima corresponding to the high symmetry lines of the Brillouin zone. The hole content n_H can be determined as angular average. However, in the hole overdoped sample, the peak ratio does not reflect n_H directly. This will be discussed in the context of data on polycrystalline materials [1].

[1] M. Schneider et al., Phys. Rev. B 72, 014504 (2005)

TT 8.10 Mon 14:00 Poster A

Quasiparticle approach to electronic Raman scattering in overdoped cuprates — •WOLFGANG PRESTEL[1], BERNHARD MUSCHLER[1], YOICHI ANDO[2], SHIMPEI ONO[2], and RUDI HACKL[1] — [1]Walther-Meissner-Institut, Garching — [2]CRIEPI, Tokyo, Japan

High-T_c superconductors can be described as normal, though strongly correlated, metals in the overdoped regime. This implies that the conduction electrons in these materials can be viewed as independent quasiparticles with defined momenta and a certain lifetime. Here we explore the capability of this concept to explain the electronic Raman response in overdoped cuprates. The Raman response can be calculated in linear response theory using a generalized Kubo formula. Owing to the **k**-dependence of the Raman vertices, selected by the polarizations of the incoming and outgoing photons, different parts of the Brillouin zone can be projected out independently. In order to evaluate the Kubo formula one additionally needs the spectral function of the quasiparticles. In our model we assume a bandstructure and quasiparticle lifetimes as derived from ARPES experiments in order to calculate the Raman response for the B_{1g} and B_{2g} symmetries. Comparing model data and Raman spectra of $La_{2-x}Sr_xCO_4$ and $Bi_2Sr_2CaCu_2O_{8+\delta}$, we find remarkable agreement concerning symmetry and temperature dependences in both material systems. This suggests that the quasiparticle approach is a reasonable starting point to explain carrier dynamics in overdoped cuprates.

The project has been supported by the DFG under grant number Ha2071/3-1 via the Research Unit FOR538.

TT 8.11 Mon 14:00 Poster A

Elektromagnetischer Response und Raman-Streuung in unkonventionellen Supraleitern — •LUDWIG KLAM und DIETRICH EINZEL — Walther-Meißner-Institut, 85748 Garching

Wir untersuchen sowohl den eichinvarianten elektromagnetischen als auch den elektronischen Raman-Response für unkonventionelle Supraleiter mit d-Wellen- (Spin-Singulett-) Paarkorrelationen. Im stoßlosen Bereich werden frühere Resultate auf beliebige quasiklassische Wellenzahlen erweitert, mit der einzigen Einschränkung, dass das Konzept der Teilchen-Loch-Symmetrie seinen Sinn behält. Die Resultate schließen notwendige Verallgemeinerungen der Lindhardfunktion, der dielektrischen Funktion, der dynamischen Leitfähigkeit und der Raman-Responsefunktion des Supraleiters auf beliebige Wellenzahlen ein. Die Theorie behält die wichtige Eigenschaft der Eichinvarianz und garantiert somit die Transversalität der Suprastroms im stationären Limes. Auch das Wechselspiel zwischen der langreichweitigen Coulomb-Wechselwirkung und der Bogoliubov-Anderson- (Eich-) Mode des Supraleiters behält seine qualitative Bedeutung bei beliebigen Wellenzahlen.

TT 8.12 Mon 14:00 Poster A

Response und Relaxation in unkonventionellen Supraleitern — •LUDWIG KLAM und DIETRICH EINZEL — Walther-Meißner-Institut, 85748 Garching

Wir untersuchen den stoßlimitierten elektronischen Raman-Response und die Ultraschallabsorption für unkonventionelle Supraleiter mit d-Wellen- (Spin-Singulett-) Paarkorrelationen bei tiefen Temperaturen. Die hier dominierenden elastischen Stöße werden im Rahmen einer T-Matrix-Näherung betrachtet, die sich auf reine s-Wellenstreuung beschränkt. Im langwelligen Limes ergibt sich eine Zweiflüssigkeits- beschreibung, bei der die Stöße ausschließlich die (Relaxations-) Dynamik des (Bogoliubov-) Quasiteilchengases dominieren und die sich je nach Transportprozess (Raman, Impulsstrom) durch unterschiedliche Quasiteilchen-Relaxationzeiten beschreiben lassen. Bei einer Anwendung auf quasi-zweidimensionale Systeme wie die Kuprat-Supraleiter zeigt sich, dass der mit der Raman-Streuintensität verknüpfte Transportparameter für B1g- und B2g-Photonpolarisation sehr eng mit entsprechenden Komponenten des Viskositätstensors korreliert ist, welche die Ultraschallabsorption dominieren. Bei tiefen Temperaturen sind analytische Lösungen der Transportgleichungen möglich, die sowohl den Grenzfall schwacher (Born-Limes) und starker (unitärer Limes) Streuung einschließen.

TT 8.13 Mon 14:00 Poster A

Time-dependent Gutzwiller theory of pair fluctuations in the attractive Hubbard model — •FALK GÜNTHER and GÖTZ SEIBOLD — BTU Cottbus, PO BOX 101344, 03013 Cottbus

The time-dependent Gutzwiller approximation (TDGA) is extended towards the inclusion of pair correlations.

The expansion of the charge-rotational invariant Gutzwiller energy functional around the saddle point allows the computation of dynamic correlation functions using the random-phase approximation (RPA). Unlike the BCS approach the interaction kernel in the TDGA mediates intersite pair scattering and also contains processes where pairs of electrons are created and annihilated on distant sites. It turns out that the TDGA can capture the crossover from weak to strong coupling in good agreement with Quantum Monte Carlo calculations in contrast to the BCS approximation.

As a further application we evaluate the excitations of the superconducting ground state. From the calculation of the instabilities in the particle-hole channel we construct the phase diagram for superconducting and charge order in two dimensional lattices.

TT 8.14 Mon 14:00 Poster A

Superconducting critical temperature and Fermi surface of hydrated cobalt compounds — •JOSE ROBERTO IGLESIAS, CHRISTOPHER THOMAS, and ACIRETE SIMOES — Instituto de Fisica, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil

We study the properties of some hydrated superconducting cobalt compounds of the type of $Na_xCoO_2{\cdot}y(H_2O)$ in the superconducting phase. These compounds consist of CoO_2 layers separated by Na ions and water molecules, resulting in a Co triangular lattice. The theoretical approach here considered is an extended Hubbard model and we obtain the normal and anomalous Green functions of the system limit using mean field approximation for the inter-atomic interactions and Hubbard-I approximation for the intra-atomic ones. We consider the paramagnetic case and we analyze the coupling between electrons with different symmetries, so obtaining the singlet and triplet superconducting order parameters. The superconducting transition temperatures, T_c, are obtained in both cases. The doping dependence of T_c obtained for the triplet case is in a qualitative agreement with experimental results. Finally the Fermi surface is also calculated and compared with ARPES results.

TT 8.15 Mon 14:00 Poster A

Influence of Andreev bound states on the screening current and the magnetic field in a d-wave superconductor. — •ALEXANDER MARKOWSKY, THOMAS DAHM, and NILS SCHOPOHL — Universität Tübingen, Lehrstuhl für Theoretische Festkörperphysik, Auf der Morgenstelle 14, 72076 Tübingen

In the present work, we investigate how the Meissner-Ochsenfeld effect is modified near a surface of a d-wave superconductor. In a d-wave superconductor, surface Andreev bound states form within the energy gap depending on the orientation of the d-wave pairing condensate

with respect to the boundary. By means of the Eilenberger theory, we study the influence of an external magnetic field on the Andreev bound states and the screening currents. In particular, the current changes its direction at the surface and a splitting of the bound state can be seen. We study the temperature dependence and orientational dependence of this effect.

TT 8.16 Mon 14:00 Poster A

Superconductivity in a semiconductor - interband interaction — •Susanne Killiches[1] and Khandker Quader[2] — [1]Institut fuer Physik, Universitaet Rostock — [2]Department of Physics, Kent State University, OH USA

Recent experiments [Steiner,Kapitulnik, Physica C, Volume 422, Issue 1-2 p.16-26, 05/2005] have demonstrated that superconductivity can grow out of a non-metallic insulating phase. To explain that phenomena we study a simplified two band model. The idea for explanation is to introduce an attraction in the valence and conduction band of either intra- or inter band nature. The transition to a superconducting phase should occur if the gain in pairing energy by forming an electron-electron pair is greater than its cost [Jrome, Rice, Kohn, Phys. Rev. 158, 462475, 1967]. Using the Matsubara Greens function method, a gap equation for a semiconductor model in 2D is derived, allowing only for inter-band interaction [Nozieres, Pistolesi, European Physical Journal B, Volume 10, #4, 08/1999]. The characteristic gap equation is solved for zero and finite temperature numerically and the behaviour of the transition temperature depending on the excitation gap and order parameter is shown. We find superconductivity, if the coupling exceeds a certain threshold and obtain a successful model to describe the superconductor-insulator transition.

TT 8.17 Mon 14:00 Poster A

Novel superconducting graphite compound: CaC_6 - synthesis and conduction electron spin resonance study — •Ferenc Murányi, Grzegorz Urbanik, Vladislav Kataev, and Bernd Büchner — Leibniz Institute for Solid State and Materials Research Dresden, 01171 Dresden, PO BOX 270116, Germany

The superconductivity in calcium intercalated graphite (CaC_6) with transition temperature (T_c) of 11.5 K was discovered in 2005. The new material attracts great attention because of its high T_c among intercalated graphite compounds, highly anisotropic critical field (H_{c2}) and layered structure like MgB_2 or high temperature superconductors. Bulk intercalated samples were prepared during 10 days' heat treatment of graphite pieces at 350 °C in Li rich Ca/Li alloy. Conduction Electron Spin Resonance (CESR) lines were observed in the temperature range from 4 K to 300 K at 9.5 GHz, in two magnetic field orientations, H‖ c and H‖ ab. The lineshape can be described as a Dysonian line which is characteristic of thick slabs of metals. The g factor ($g_c = g_{ab} = 1.9984$ +/- 0.0005), the linewidth ($w_c = w_{ab} = 4$ +/- 0.5 G) and the intensity are typical for the metallic state, in both magnetic field orientations.

TT 8.18 Mon 14:00 Poster A

Angular dependant critical field and critical currents of epitaxial Holmium Nickel Borocarbide Thin Films — •Tim Niemeier, Ruben Hühne, Günter Behr, Ludwig Schultz, and Bernhard Holzapfel — IFW Dresden, P.O. Box 270116, 01171 Dresden

Epitaxial thin films of $HoNi_2B_2C$ and related superconducting rare earth borocarbide compounds act as a suitable basis for numerous investigations on structural and superconductive properties such as T_c, H_{c2} and J_c.

A new batch of $HoNi_2B_2C$ thin films was grown on ceramic single crystal magnesium oxide substrates under ultra-high vacuum conditions using pulsed laser deposition. A detailed view on the deposition parameters and the physical film properties is presented and angular H_{c2}- and J_c-measurements are shown.

TT 8.19 Mon 14:00 Poster A

Determination of the band structure of $LuNi_2B_2C$ — •Beate Bergk[1,2], Marek Bartkowiak[1], Oleg Ignatchik[1], Manfred Jäckel[2], Joachim Wosnitza[3], Helge Rosner[3], Vivien Petzold[3], and Paul Canfield[4] — [1]Hochfeld-Magnetlabor Dresden, Forschungszentrum Dresden-Rossendorf, D-01314 Dresden, Germany — [2]Institut für Festkörperphysik, TU-Dresden, D-01062 Dresden, Germany — [3]MPI für chemische Physik fester Stoffe, D-01187 Dresden, Germany — [4]Condensed Matter Physics, Ames Laboratory, Ames, Iowa 50011,

We present de Haas-van Alphen (dHvA) investigations on the non-magnetic borocarbide superconductor $LuNi_2B_2C$ which have been performed by use of the torque method in high magnetic fields up to 32 T and at low temperatures down to 50 mK. The complex band structure is extracted from the quantum oscillations in the normal state. In comparison with full-potential-local-orbital calculations of the band structure we are able to assign the observed dHvA frequencies to the different bands. Temperature dependent dHvA investigations allowed the extraction of the effective band masses for the several Fermi-surface sheets. We observe an enhancement of the effective masses compared to the theoretical calculations which is due to electron-phonon interaction. Finally, we are able to examine the angular dependence of the electron-phonon coupling for the different Fermi-surface sheets.

TT 8.20 Mon 14:00 Poster A

Superconductivity and electron-phonon coupling in doped MgB_2 and related compounds — •Vivien Petzold[1], Klaus Koepernik[1,2], and Helge Rosner[1] — [1]MPI CPfS Dresden, Germany — [2]IFW Dresden, Germany

Recently, substitutions on the Mg site in MgB_2, e.g., $Mg_{1-x}Sc_xB_2$, $Mg_{1-x}(AlLi)_xB_2$ were investigated intensively. For achievable doping levels, $Mg_{1-x}Sc_xB_2$ shows only very small structural changes but clear changes in the electronic structure, whereas AlLi doping affects the lattice parameters but has almost no influence on the electronic structure. Our theoretical approach comprises different approximations in the framework of band structure calculations: the rigid band and virtual crystal method as well as supercell calculations and coherent potential approximation. We show that the latter two lead to consistent results with respect to lattice expansion and electronic properties. We show that lattice effects are of minor importance. Concluding that the B 2p σ states remain the most relevant subsystem with regard to superconductivity, we calculated the electron phonon coupling constant λ and the critical temperature T_c. In contrast, for ZrB_2 as a typical representative of transition metal diborides TB_2 we find the sp^2(B)-d(T) hybridization to be crucial. Comparing calculated and measured angle dependent dHvA-data we show that: (i) LDA provides an excellent description of the electronic structure of TB_2. (ii) The electron phonon coupling is too small to expect superconductivity above a few mK for the stoichiometric compounds.

The Emmy-Noether program is acknowledged for financial support.

TT 8.21 Mon 14:00 Poster A

Nonlinear Temperature Dependence of the Upper Critical Magnetic Field for Magnesium Diboride — •Thomas Koch[3], Thomas Schimmel[3,4], Maria Palistrand[2], Vladimir Zdravkov[1], and Anatolie Sidorenko[1] — [1]Institute of Electronic Engineering and Industrial Technologies, ASM, MD-2028 Kishinev, Moldova — [2]Institute of Applied Physics, ASM, MD-2028 Kishinev, Moldova — [3]Institute of Nanotechnology, Forschungszentrum Karlsruhe D-76021 Karlsruhe, Germany — [4]Institute of Applied Physics, University of Karlsruhe D-76128 Karlsruhe, Germany

The temperature dependence of the upper critical magnetic field, Hc_2(T), for MgB_2 films was investigated. As one result a nonlinear behavior of Hc_2(T) shown in the positive curvature in the H(T) plots is found to be an intrinsic property of the novel superconducting material. The experimental results are compared with the calculations made within the theoretical model of inter-band interaction for multi-band superconductors.[1]

Reference 1. M. E. Palistrant, Upper Critical Field Hc_2 in Two-Band Superconductors, Mold.Journ. Phys.Sci 3 (2004) 61

TT 8.22 Mon 14:00 Poster A

Enhanced superconductivity of Pb nanograins on a biological substrate — •T. Herrmannsdörfer[1], O. Ignatchik[1], T. P. Papageorgiou[1], F. Pobell[1], C. Walter[1], J. Wosnitza[1], C. Hennig[2], M. Merroun[2], K. Pollmann[2], J. Raff[2], S. Selenska-Pobell[2], and J. von Borany[3] — [1]Hochfeld-Magnetlabor Dresden (HLD), — [2]Institut für Radiochemie, — [3]Institut für Ionenstrahlphysik und Materialforschung, Forschungszentrum Dresden-Rossendorf, D-01314 Dresden, Germany

Nanogranular materials attract more and more attention due to their exciting physical properties as well as their key role in future technologies. Compared to their bulk counterparts, nanogranular materials can reveal strongly altered properties. As an example, we have demonstrated that the Stoner enhancement factor of the d conduction-electron susceptibility of Pd and Pt nanoclusters is clearly reduced

compared to the one of the bulk transition metals. Now we have focused on superconducting properties of lead particles of a well defined single grain size of 19 nm. As for Pd and Pt, these metal nanoclusters have been deposited on a biological template, a purified self-assembling paracrystalline surface layer (S-layer) of Bacillus sphaericus JG-A12 which is composed of identical protein monomers. After a determination of their grain size using x-ray powder diffraction, we have investigated their superconducting B-T phase diagram by means of SQUID magnetometry. The Pb clusters reveal a superconducting critical field of the size of several Tesla which is strongly enhanced compared to the corresponding critical magnetic field of 0.09 T for bulk Pb.

TT 8.23 Mon 14:00 Poster A

Strong anisotropic superconducting behavior in the dichalcogenide $SnSe_2$ intercalated with cobaltocene — •Robert Miller[1], Sandra Altmannshofer[1], Ernst-Wilhelm Scheidt[1], Rudolf Herrmann[1], Franz Mayr[2], Dietrich Einzel[3], and Wolfgang Scherer[1] — [1]CPM, Institut für Physik, Universität Augsburg, 86135 Augsburg, Germany — [2]EP V – EKM, Institut für Physik, Universität Augsburg, 86135 Augsburg, Germany — [3]Walther-Meissner-Institut für Tieftemperaturforschung, 85748 Garching, Germany

We present a detailed study of the layered dichalcogenide $SnSe_2$ intercalated with the organometallic donor molecule cobaltocene, which exhibits a superconducting transition at $T_c = 6\,K$. The extremely anisotropic superconducting behavior is reflected by an in-plane and off-plane resistivity, which deviate from each other by a factor of 200 just before superconductivity sets in. Furthermore, this strong anisotropy leads to two different superconducting transition temperatures, one goes in line with the in-plane and the other with the off-plane superconductivity . In addition, specific heat studies clearly characterize the intercalated $SnSe_2$ as a bulk superconductor with these two different T_c's.

TT 8.24 Mon 14:00 Poster A

Superconducting transport properties of Co-Pt/Nb/Co-Pt triple layers with perpendicular magnetic anisotropy — •Ajay Singh[1], Christoph Sürgers[1,2], and Hilbert v. Löhneysen[1,2,3] — [1]Physikalisches Institut, Universität Karlsruhe, D-76128 Karlsruhe — [2]Center for Functional Nanostructures, Universität Karlsruhe, D-76128 Karlsruhe — [3]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, D-76021 Karlsruhe

In a superconducting spin switch the transition temperature T_c of a superconductor (S) sandwiched between two ferromagnets (F) depends on the relative orientation of the F layer magnetizations. We report on the superconducting transport properties of FSF triple layers, where F is a Co-Pt multilayer with perpendicular magnetic anisotropy and S is Nb. T_c is lower for the antiparallel (AP) compared to the parallel (P) state. This is explained by the enhanced reflection of spin-polarized charge carriers into the S layer for the AP state. T_c is independent of the magnetization orientation if an insulating barrier is introduced between F and S at each of the two interfaces. We also provide additional data in order to prove that the T_c difference is likely to be related to the proximity effect and not due to residual magnetic stray fields of the F layers.

TT 8.25 Mon 14:00 Poster A

Electronic Transport in Superconductor-Ferromagnet-Heterostructures — •Dagmar Rall[1], Jakob Brauer[1], Detlef Beckmann[1], and Hilbert v. Löhneysen[2,3] — [1]Forschungszentrum Karlsruhe, Institut für Nanotechnologie — [2]Forschungszentrum Karlsruhe, Institut für Festkörperphysik — [3]Physikalisches Institut, Universität Karlsruhe

Electronic transport in nanoscale superconductor-ferromagnet (SF) contacts at very low temperature is studied in order to identify nonlocal Andreev bound states. The samples consist of two parallel ferromagnetic film strips between superconducting leads. The strips are magnetized to exhibit a magnetic field which discourages direct Andreev reflection at the respective SF - interfaces. However, if the magnatization is antiparallel and the distances sufficiently small, the setup allows for a non-local reflection of the electrons in one strip to holes in the other strips and vice versa. This way, a bound state may form, giving rise to a Josephson current across the junction.

TT 8.26 Mon 14:00 Poster A

Nonlocal transport in superconductor/normal metal heterostructures — •Jakob Brauer[1], Detlef Beckmann[1], and Hilbert v. Löhneysen[2,3] — [1]Forschungszentrum Karlsruhe, INT — [2]Forschungszentrum Karlsruhe, IFP — [3]Physikalisches Institut, Universität Karlsruhe

Injection of electrons from a normal metal into a superconductor with electron energies below the superconducting gap Δ (measured from the Fermi energy) is only possible by means of Andreev reflection, where an incident electron gets reflected as a hole with opposite spin at the NS interface.

If multiple interfaces are present nonlocal (or crossed) Andreev reflection (CAR) and electron cotunneling (EC) can occur. For an electron injected at an interface A, CAR leads to an emitted hole at a different interface B. On the other hand electron cotunneling yields an emitted electron at B.

To observe these effects we examine samples created by e-beam lithography and shadow evaporation technique. These consist of multiple NS (copper/aluminium) tunnel junctions with spatial seperation of injector and detector contacts of around 150 nm. We present experimental data on local and nonlocal electronic transport measurements.

TT 8.27 Mon 14:00 Poster A

Enhanced stray field compensation in Nb/FePt bilayers — •Silvia Haindl, Martin Weisheit, Sebastian Fähler, Ludwig Schultz, and Bernhard Holzapfel — Institute for Metallic Materials, IFW, Postfach 27 01 16, 01171 Dresden, Germany

Epitaxial Nb/FePt thin film bilayers were prepared by pulsed laser deposition under UHV conditions. FePt is a highly coercive ferromagnet and therefore shows no switching in the field range of the superconducting phase at low temperatures. With the magnetic moments of the FePt grains aligned perpendicular to the film plane, the stray field between the individual grains acts already on the superconductor in the field-free case. Under application of a magnetic field, the stray field can be compensated, accompanied by an observable increase of the transition temperature. Using hard magnetic materials an enhanced effect of stray field compensation was observed when 0.25 T of applied field raises T_C about 0.5 K. The B(T)-phase diagram of the heterostructures was investigated, and its behavior was controlled by varying the FePt layer thickness.

TT 8.28 Mon 14:00 Poster A

Odd Triplet Superconductivity in Superconductor/Ferromagnet Structure with a Spiral Magnetic Structure — •Alexandra Anishchanka — Querenburger Hoehe, 97, Bochum, 44801, Deutschland

We analyze a superconductor-ferromagnet (S/F) system with a spiral magnetic structure in the ferromagnet F for a weak and strong exchange field. The long-range triplet component (LRTC) penetrating into the ferromagnet over a long distance is calculated for both cases. In the dirty limit (or weak ferromagnetism) we study the LRTC for conical ferromagnets. Its spatial dependence undergoes a qualitative change as a function of the cone angle ϑ. At small angles ϑ the LRTC decays in the ferromagnet exponentially in a monotonic way. If the angle ϑ exceeds a certain value, the exponential decay of the LRTC is accompanied by oscillations with a period that depends on ϑ. This oscillatory behavior leads to a similar dependence of the Josephson critical current in SFS junctions on the thickness of the F layer. In the case of a strong ferromagnet the LRTC decays over the length which is determined by the wave vector of the magnetic spiral and by the exchange field.

TT 8.29 Mon 14:00 Poster A

A quest for the optimal design of π-coupled Josephson junctions — •Dirk Sprungmann, Kurt Westerholt, and Hartmut Zabel — Institut für Experimentalphysik/Festkörperphysik, Ruhr-Universität Bochum, 44780 Bochum

In recent years investigations of so called π-coupled Josephson junctions became very popular. In an ordinary currentless SIS or SNS junction the pair wave functions on both sides of the tunnel barrier have a phase shift of zero. By introducing a thin ferromagnetic layer with a certain thickness d_{Fc} between the two superconductors it is possible, to obtain a phase shift of π between the two superconducting layers in the ground state. This causes a sign change of the critical Josephson current I_c and leads to a crossover within the $I_c(d_F)$-curve. To establish a solid basis to analyse these electronic components systematically, we first tried to find an optimal design of the junction. In order to avoid any breaking of the vacuum and to keep all the interfaces in the junction clean, we checked two in-situ preparation procedures, in which only shadow masks and dry-etching processes are applied. We

will compare these in-situ designs with established concepts using e-beam lithography. We present abortive and successfull sample designs of these exciting electronic devices and describe advantages disadvantages as well as crucial pitfalls. We acknowledge financial support through SFB 491.

TT 8.30 Mon 14:00 Poster A

0 and π phase Josephson coupling through an insulating barrier with magnetic impurities — •O. Vávra[1,2,3], Š. Gaži[2], I. Vávra[2], D. S. Golubović[1], J. Dérer[2], and V. V. Moshchalkov[1] — [1]Nanoscale Superconductivity and Magnetism Group, Laboratory for Solid State Physics and Magnetism, K. U. Leuven, Celestijnenlaan 200 D, B-3001 Leuven, Belgium — [2]Institute of Electrical Engineering, Slovak Academy of Sciences, Dúbravská cesta 9, SK-841 04 Bratislava, Slovak Republic — [3]Institut für experimentelle und angewandte Physik, Universität Regensburg, D-93025 Regensburg, Germany

We present the experimental evidence of the existence of the π state in the Josephson junction with magnetic impurities in the insulating barrier. We have studied temperature and field dependencies of the critical current I_C in the Nb-$Fe_{0.1}Si_{0.9}$-Nb Josephson junction with tunneling barrier formed by paramagnetic insulator. We demonstrate that in these junctions the co-existence of both the 0 and the π states within one tunnel junction takes place which leads to the appearance of a sharp cusp in the temperature dependence $I_C(T)$ similar to the $I_C(T)$ cusp found for the $0-\pi$ transition in metallic π junctions. This cusp is not related to the $0-\pi$ temperature induced transition itself, but is caused by the different temperature dependencies of the opposing 0 and π supercurrents through the barrier.

TT 8.31 Mon 14:00 Poster A

Josephson π-junctions and their application in superconducting flux qubits — •Georg Wild, Achim Marx, and Rudolf Gross — Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, 85748 Garching, Germany

Superconducting flux qubits suffer from the need of a flux bias, which has to be extremely stable in time. This problem can be circumvented by inserting an additional π-phase shift element in the qubit ring, which formally replaces this flux bias. A phase shift of π between the phases of two superconductors (S) is provided by a Josephson junction (JJ), where the weak coupling is established by a thin ferromagnetic metal layer (F) of appropriate thickness. For applications in quantum circuits, where damping and decoherence has to be minimized, an insulating layer (I) is needed to increase the quality factor of the junction. For the realization of flux qubits with π-phase shift elements we have developed an in-situ self-aligned multilayer process to realize SIFS-JJ. Our junctions show RCSJ-like current-voltage characteristics and a Fraunhofer pattern like modulation of the critical current with magnetic field. The dependence of the I_cR_n-product on the ferromagnet thickness shows a crossover between the zero- and the π-state.
This work was supported by the DFG via SFB 631.

TT 8.32 Mon 14:00 Poster A

Investigation of dynamic effects in 0, π and 0-π SIFS Josephson junctions — •Judith Pfeiffer[1], Edward Goldobin[1], Martin Weides[2], Matthias Kemmler[1], Andreas Dewes[1], Dieter Koelle[1], and Reinhold Kleiner[1] — [1]Universität Tübingen, Experimentalphysik II, Auf der Morgenstelle 14, D-72076 Tübingen, Germany — [2]Forschungszentrum Jülich GmbH, Institut für Festkörperforschung, 52425 Jülich

We present experimental and numerical studies of high quality underdamped SIFS Josephson junctions (JJ) fabricated as $Nb/Al_2O_3/Cu_{40}Ni_{60}/Nb$ heterostructures. Varying the thickness of the ferromagnetic barrier we can create 0, π and 0-π junctions. From measurements of the current voltage characteristic (*IVC*) and critical current I_c vs. magnetic field H we find record values for the critical current density j_c in the π-state. The $I_c(H)$ data for the 0-π JJ show a clear minimum at $H = 0$. Dynamical phenomena such as Fiske steps and zero field steps are visible on the *IVCs*. In the case of the 0-π junction we are able to detect a half-integer zero field step due to the dynamics of a semifluxon. The dissipation in all these JJs is not linear, but the linear part decreases exponentially with a decreasing temperature in the range between 4.2 and 2.1 K.

TT 8.33 Mon 14:00 Poster A

Spectroscopy of the fractional vortex eigenfrequency in a long Josephson 0-κ junction — •Kai Buckenmaier[1], Tobias Gaber[1], Inga Schittenhelm[1], Michael Siegel[2], Reinhold Kleiner[1], Dieter Koelle[1], and Edward Goldobin[1] — [1]Physikalisches Institut, Experimentalphysik II, Universitaet Tuebingen, Auf der Morgenstelle 14, D-72076 Tuebingen, Germany — [2]Universitaet Karlsruhe, Institut fuer Mikro– und Nanoelektronische Systeme, Hertzstr. 16, D-76187 Karlsruhe, Germany

In long Josephson junctions with a κ-phase discontinuity, created by two current injectors, a fractional Josephson vortex (FJV) is spontaneously formed at the interface between the 0- and κ-part. A FJV carrys an arbitrary fraction $\Phi/\Phi_0 = \kappa/2\pi$ of the magnetic flux quantum $\Phi_0 \approx 2.07 \times 10^{-15}$ Wb. In contrast to fluxons, FJVs are pinned at the discontinuity point, but in underdamped systems they are able to oscillate around their equilibrium point with characteristic eigenfrequencies. To experimentally determine the eigenfrequency we stimulated a FJV by irradiating our sample with microwaves. At resonance the junction switches to the resistive state. A measurement of the switching probability thus allows to determine the FJV eigenfrequency as a function of bias current and κ. We compare our results with the prediction of the pertubed sine-Gordon equation.

TT 8.34 Mon 14:00 Poster A

Thermal activation and phase diffusion in long submicron annular junctions — •Astria N. Price[1], Alexander Kemp[1], William D. Oliver[2], and Alexey V. Ustinov[1] — [1]Physikalisches Institut III, Universität Erlangen-Nürnberg, Erwin-Rommel-Str 1, 91058 Erlangen, Germany — [2]MIT Lincoln Laboratory, 244 Wood Street, Lexington, Massachusetts 02420, USA

We report measurements of the standard deviation of the switching current from the flux-free state in long annular Josephson junctions of differing submicron width, over the temperature range T ˜ 25 - 750 mK. A power law dependence is observed between 200 and 500 mK, while at lower temperatures the standard deviation saturates due to phase escape via quantum tunneling. As the temperature increases above T ˜ 500 mK the standard deviation decreases, which we interpret as an observation of phase diffusion in an extended Josephson system.

TT 8.35 Mon 14:00 Poster A

Superconductor-Constriction-Superconductor Josephson Junction in a Magnetic Field — •Andreas Gumann, Thomas Dahm, and Nils Schopohl — Universität Tübingen, Lehrstuhl für Theoretische Festkörperphysik, Auf der Morgenstelle 14, 72076 Tübingen

Josephson junctions can be formed by a constriction of a superconducting material with lateral extension smaller than the coherence length. This kind of weak link, often referred to as ScS Josephson junction, is a useful starting point for theoretical considerations since only the properties of the superconductor and the geometry are relevant. We present self-consistent solutions of microscopic Eilenberger theory for a two-dimensional model of a ScS Josephson junction including magnetic fields, external ones as well as those generated by the screening and transport currents. We show results for the order parameter amplitude and phase, the currents, the magnetic vector potential and the local density of states. In particular, the effect of the external magnetic field on the Andreev bound states appearing in the junction is studied.

TT 8.36 Mon 14:00 Poster A

Development of metallic magnetic calorimeters for high-resolution X-ray spectroscopy — •Markus Linck, Andreas Burck, Loredana Gastaldo, Sebastian Kempf, Jan-Patrick Porst, Hannes Rotzinger, Sönke Schäfer, Andreas Fleischmann, and Christian Enss — Kirchhoff-Institut für Physik, Universität Heidelberg, INF 227, 69120 Heidelberg, Deutschland

X-ray detectors based on the concept of magnetic calorimetry are well suited for high-resolution spectroscopy. Metallic magnetic calorimeters (MMC) make use of a metallic paramagnetic temperature sensor, gold doped with few hundred ppm erbium, which is in tight thermal contact with a metallic absorber. The sensor is placed in a weak magnetic field, its magnetization is used to monitor the temperature. High-energy resolution can be obtained by using a low-noise, high-bandwidth DC SQUID to measure the small change in magnetization upon the absorption of an X-ray.

In many applications it is important to have a detector that has a high stopping power for photons up to 10 keV and allows to measure with a high count rate. The design of the detector we present is based on a numerical calculation that gives the optimal values for sensor size,

erbium concentration and applied magnetic field. The detector has a stopping power of about 98 % at 6 keV and the decay time has been improved by a better thermal link between the sensor and the thermal bath. The energy resolution we achieved is $\Delta E_{\mathrm{FWHM}} = 2.7\,\mathrm{eV}$ for X-ray energies up to 6.5 keV.

TT 8.37 Mon 14:00 Poster A

Properties of superconducting rhenium absorber for low temperature detectors — •J.-P. Porst[1], L. Gastaldo[1], S. Schäfer[1], M. Linck[1], A. Burck[1], S. Kempf[1], H. Rotzinger[1], A. Fleischmann[1], C. Enss[1], V. Zakosarenko[2], R. Stolz[2], and H.-G. Meyer[2] — [1]Kirchhoff-Institut für Physik, Universität Heidelberg, INF 227, D-69120 Heidelberg, Germany — [2]Institute for Physical High Technology, Albert-Einstein-Str.9, D-07702 Jena, Germany

A still puzzling problem in the development of low temperature microcalorimeters for the measurement of ^{187}Re β-spectrum, is the understanding of the thermalization of energetic electrons in the superconducting rhenium absorber. We developed a metallic magnetic calorimeter (MMC) with a single crystal Re absorber and paramagnetic Au:Er temperature sensor. The energy released into the detector leads to a change of magnetization of the paramagnetic sensor located in a weak magnetic field. A meander shaped SQUID magnetometer is used to read out this change. This setup allows the study of several properties of the rhenium single crystal. The transition to the superconducting state is studied by measuring the magnetic flux expelled by the Re sample. The resistivity of Re above T_C can be estimated from the measurement of the spectral power density of the Johnson noise. Furthermore the quasiparticle lifetime can be investigated through the analysis of heat pulses caused by the absorption of X-rays. We present the data obtained in these experiments and discuss the physical quantities which can be derived from these.

TT 8.38 Mon 14:00 Poster A

Characterization of 3-dimensional superconductive thin film components for gravitational experiments in space. — •Stefan Hechler[1], Ronny Nawrodt[1], Sandor Nietzsche[1], Wolfgang Vodel[1], Hansjörg Dittus[2], Frank Löffler[3], and Paul Seidel[1] — [1]Friedrich-Schiller-Universität Jena, Institut für Festkörperphysik, Helmholtzweg 5, 07743 Jena, Germany — [2]ZARM, Universität Bremen, Am Fallturm, 28359 Bremen, Germany — [3]Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig, Germany

Superconducting Quantum Interference Devices (SQUIDs) are used for high precise gravitational experiments. One of the most impressive experiments is the Satellite Test of the Equivalence Principle (STEP) of NASA/ESA. The STEP mission aims to prove a possible violation of Einstein's Equivalence Principle at an extreme level of accuracy of 1 part in 10^{18} in space.

In this contribution we present an automatically working measurement equipment to characterize 3-dimensional superconducting thin film components like i.e. pick-up coils and test masses for STEP. The characterization is done by measurements of the transition temperature between the normal and the superconducting state using a special built anti-cryostat. Above all the setup was designed for use in normal LHe transport Dewars. The sample chamber has a volume of 150 cm^3 and can be fully temperature controlled over a range from 4.2 K to 300 K with a resolution of better then 100 mK.

This work was supported by German DLR, contract 50 OY 0501.

TT 8.39 Mon 14:00 Poster A

Characterisation of new HTSC-gradiometers for spatial resolved measurments — •Alexander Steppke[1], Märit Djupmyr[2], Christoph Becker[1], Veit Grosse[1], Joachim Albrecht[2], Frank Schmidl[1], and Paul Seidel[1] — [1]Institut für Festkörperphysik, Friedrich-Schiller-Universität Jena, Germany — [2]Max-Planck-Institut für Metallforschung, Stuttgart, Germany

We present a new layout for a high-T_c dc-SQUID gradiometer for spatially resolved measurements. The gradiometers were made on $SrTiO_3$ bicrystal substrates using pulsed laser deposition. The 150 nm $YBa_2Cu_3O_{7-x}$ films were structured using Argon ion beam etching.

An overview of the characteristic parameters of these HTSC-SQUIDs is given. We measured I_c, I_cR_n-product, transfer function depending on temperature and noise properties in environments shielded and unshielded from magnetic fields. Comparisons with numerical simulations of the electrical properties and magnetooptical images showing current densities in different fields are given.

Several applications are discussed with respect to the balance and effective area of the gradiometer structures.

TT 8.40 Mon 14:00 Poster A

Electromagnetic Exploration with SQUID magnetometers — •Andreas Chwala, Ronny Stolz, Nikolai Uhkansky, Frank Bauer, and Hans-Georg Meyer — Institute for Physical High Technology, Albert-Einstein-Straße 9, D-07745 Jena, Germany

Electromagnetic methods are widely used in geophysical exploration to detect conductivity anomalies, which are a marker for a variety of ore deposits. Transient ElectroMagnetics (TEM) is a standard method for ground based and airborne exploration: A rectangular-like excitation field (primary signal) generates eddy currents in the ground and the corresponding secondary field of the decaying eddy is measured after the primary field is switched off. By this means, an apparent resistivity depth profile can be calculated.

Since SQUIDs are much more sensitive than coils at low frequencies and measure the B field directly they can extend the exploration depth in TEM significantly. IPHT Jena has developed HTS and LTS SQUID systems for TEM. One major demand for such a system is a high slew rate of several milli-Tesla/second since the Flux Locked Loop has to follow the steep transients of the primary signal. The systems are designed to be robust and easy to handle. A ruggedised, water proof box holds the control unit and power supply, the cryostat is placed in a shock absorbing container, the working points of the SQUIDs are tuned automatically by using a microprocessor. The magnetic field resolution is $20\mathrm{fT}/\sqrt{Hz}$ for the LTS SQUID system. The HTS SQUID system uses an ac bias technique to reach a noise floor of $30\mathrm{fT}/\sqrt{Hz}$ above 100Hz and $100\mathrm{fT}/\sqrt{Hz}$ at 1Hz. The superiority of the SQUIDs compared to conventional induction coil type and fluxgate sensors has been demonstrated on many targets. The LTS SQUID systems are now used in routine exploration work.

TT 8.41 Mon 14:00 Poster A

Fabrication of Josephson based superconducting quantum devices — •Tobias Heimbeck, Sonia Dandl, Achim Marx, and Rudolf Gross — Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, D-85748 Garching

Superconducting qubits based on superconducting loops containing an odd number of Josephson junctions with a Josephson coupling energy larger than the charging energy are called flux qubits. The qubit states are given by a symmetric superposition of states corresponding to clockwise and counter clockwise circulating currents at a flux bias of half a flux quantum. We have fabricated superconducting flux qubits based on $Al/AlO_x/Al$ tunnel junctions, using electron beam lithography and shadow evaporation technique. Junctions with areas down to $100 \times 100\,\mathrm{nm}^2$ could be realized . A crucial point was to establish and optimize the oxidation process for the lower electrode as well as to design the electromagnetic environment by suitable shunting capacitors and resistors. We established a process allowing to fabricate on chip $Al/AlO_x/Al$ capacitors. Using either optical or electron beam lithography we realized capacitors with a specific capacitance of $14\,\mathrm{fF}/\mu\mathrm{m}^2$. And resistance values well above $100\,\mathrm{M}\Omega$ for capacitor areas up to $1000\,\mu\mathrm{m}^2$. These capacitors are suited as on chip shunting capacitors for flux qubits, isolating the qubits from environmental noise sources.

This work was supported by the DFG via SFB 631.

TT 8.42 Mon 14:00 Poster A

Numerical simulation of an oscillator driven by a superconducting single electron transistor — •Michael Marthaler and Gerd Schön — Institut für Theoretische Festkörperphysik, Universität Karlsruhe, D-76128 Karlsruhe, Germany

We study a quantum oscillator, capacitively coupled to a superconducting single electron transistor (SSET). Transitions between charge states on the island lead to excitations in the oscillator. Our analysis focuses on the behavior of the oscillator in the vicinity of the JQP resonance. Using a dressed state approach we can calculate the probability distribution of the oscillator states. As proposed by NEC-Group (Astafiev *et. al*) one should get a laser-like behavior if the oscillator is at resonance with the Josephson oscillations in the SSET. We were able to verify this.

TT 8.43 Mon 14:00 Poster A

Interaction-Induced Renormalization of Andreev Reflection — •Wolfgang Belzig, Mikhail Titov, and Markus Müller — Department of Physics, University of Konstanz, 78457 Konstanz

Understanding the influence of interaction effects is of fundamental im-

portance in the study of electronic transport through low-dimensional nanostructures. In our work we analyze the charge transport between a one-dimensional weakly interacting electron gas and a superconductor within the scaling approach in the basis of scattering states. We derive and solve the renormalization group equations [1], which fully take into account the intrinsic energy of the scattering matrix due to Andreev reflection. We find a strong renormalization of the Andreev reflection phase even for a prefectly transparent normal metal-superconductor interface. We discuss the effect of this unexpected phase renormalization on the supercurrent through a long superconductor-normal metal-superconductor junction. Our results predict a high sensitivity of the interaction-induced suppression of the Andreev conductance on the normal-state resistance, and thereby provide a possible explanation of experiments with single-walled carbon-nanotube/superconductor junctions [2].

[1] M. Titov, M. Müller, and W. Belzig, Phys. Rev. Lett. **97** 237006 (2006).
[2] A. F. Morpurgo, J. Kong, C. M. Marcus, and H. Dai, Science **286**, 263 (1999).

TT 8.44 Mon 14:00 Poster A

Transversal Flux-Transformer Effect in Narrow Superconducting Channels of a-$Nb_{0.7}Ge_{0.3}$ — •F. Otto[1], M. Frisch[1], A. Helzel[1], A. Bilušić[1], D. Babić[2], C. Sürgers[3], and C. 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 study nonlocal vortex transport in mesoscopic amorphous $Nb_{0.7}Ge_{0.3}$ samples. A dc current I is passed through a wire connected via a perpendicular channel, of a length $L = 2 - 5\,\mu m$ and width $w = 0.1 - 2\,\mu m$, with a pair of voltage probes where a nonlocal response V_{nl}/I is measured. In our low-pinning a-$Nb_{0.7}Ge_{0.3}$, the effect appears in more than half of the superconducting phase diagram, i.e. everywhere where the vortices can be moved easily enough to induce dissipation at very low currents. The maximum of $R_{nl} = V_{nl}/I$ for a given temperature occurs at an L-independent magnetic field and is proportional to $1/L$. The influence of the vortex-matter viscosity alone is more easily studied in the limit $T \to T_c$, where pinning effects are negligible. We present a detailed study of the T- and w-dependence of the effect.

TT 8.45 Mon 14:00 Poster A

Transport of magnetic flux quanta by Surface Acoustic Waves — •Munise Rakel, Fabian Jachmann, and Carsten Hucho — Paul-Drude-Institut, Hausvogteiplatz 5-7, 10117 Berlin

We report on the interaction between a traveling surface acoustic wave (SAW) and the ensemble of magnetic flux quanta (vortices) in a type II superconductor in the Shubnikov phase. The possibility of manipulating the motion and density of single flux quanta by a dynamic external parameter (no direct contact) has far reaching technological consequences. Here we investigate a thin film of superconducting $YBa_2Cu_3O_7$ on a piezoelectric substrate. The SAWs were generated by applying an RF-current into interdigital transducers (IDTs). This results in a DC-voltage peak in the superconducting film near the critical temperature T_c which shows both symmetric and antisymmetric contributions in the presence of a magnetic field. While the symmetric background can be related to the well known ac/dc-conversion effect, the antisymmetric part is ascribed to the SAW induced directed motion of vortices. The ultrasonic strain wave itself acts like a dynamic pinning grid to which the vortices are forced to couple. This SAW related vortex drag is, therefore, most prominent in a very narrow temperature and field range right at the boundary between the vortex glass phase and the thermally activated flux flow regime.

TT 8.46 Mon 14:00 Poster A

Microscopic study of vortex pinning in YBCO thin films — •Tetyana Shapoval, Volker Neu, Ulrike Wolff, Elke Backen, Maria Sparing, Ruben Huehne, Bernhard Holzapfel, and Ludwig Schultz — IFW Dresden, Institute for Metallic Materials, P.O. Box 270116, D-01171 Dresden, Germany

The direct microscopic imaging of flux lines by means of low-temperature MFM was applied to study the vortex pinning mechanism at natural and artificial defects in high temperature superconducting films. A low-temperature scanning probe microscope (Omicron Cryogenic SFM) allows measurements in UHV combined with magnetic fields of 7 T (vertical) and 3 T (transversal). Flux lines have been successfully imaged on a pure YBCO film as well as on a YBCO film grown on a template with gas phase prepared Y_2O_3 nanoparticles. The investigated films with a mean roughness less than 10 nm were deposited by off-axis PLD and cooled down in the microscope to 7.7 K in a magnetic field prior to imaging. The number of vortices observed corresponds to the theoretically expected one. The vortex distribution was compared with the topography. The *in situ* transport measurements allow an estimation of the pinning strength at the different defects present in the sample. For future studies on chemical deposited films a mechanical polishing procedure is developed to obtain sufficiently smooth sample surfaces.

TT 8.47 Mon 14:00 Poster A

Comparative experimental and theoretical study of flux dynamics in homogeneous high-T_c superconducting films — Carolina Romero-Salazar[1], Christian Jooss[1], and •Omar Hernandez-Flores[2] — [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

We investigate the magnetic flux, current and electric field distributions for flux creep, in a nearly single crystalline thick YBaCuO film via magneto-optical imaging, employing a method presented recently [1].

Additionally, we calculate numerically the induced electric field distributions in finite thickness films, in perpendicular geometry and flux creep regime. The nonlocal model is based on the flux distribution in the critical state and enables us to investigate the geometry-sample dependence of physical properties of superconducting films.

A quantitative and qualitative agreement between theoretical and experimental distributions was obtained. Understanding the vortex dynamics in homogeneous superconducting films, provides a necessary background to study inhomogeneous materials.

[1] Ch. Jooss and V. Born *Phys. Rev. B* **73**, 094508 (2006).

TT 8.48 Mon 14:00 Poster A

Matching in flux-line lattice pinned by triangular pinning array with disorder — •M. Oettinger[1], J. Eisenmenger[1], C. Pfahler[1], A. Plettl[1], U. Wiedwald[1], L. Han[1], P. Walther[2], and P. Ziemann[1] — [1]Abteilung Festkörperphysik, Universität Ulm, D-89069 Ulm, Germany — [2]Zentrale Einheit Elektronenmikroskopie, Universität Ulm, D-89069 Ulm, Germany

The interaction of a flux line lattice (FLL) with quasiperiodic pinning arrays recently attracted a lot of attention. A different type of order is found for self-organized patterns, as, e.g., a weakly disturbed FLL itself, which is characterized by a short-range triangular order but a missing directional long-range order. We prepared arrays of nanoscaled artificial pinning centers (APCs) with such order into Nb thin films. The APCs are formed by depositing Nb onto substrates covered with Si nanopillars or metal nanospheres with diameters of 10 – 50 nm. The mutual distance of pillars and spheres is about 100 nm. Nanospheres are produced by using the self-organization of inverse micelles formed by diblock-copolymers, whose core is loaded with a metal precursor, e.g., Au or FePt. Si nanopillars are formed by using an array of gold nanospheres as an etching mask during reactively ion etching a Si substrate. In this way, the pattern of the nanoparticle array is transferred onto the Si substrate. The resulting lattice of APCs, formed by the Si pillars or metal nanospheres perforating the Nb film, mirrors the order of the micellar array. By nanoshaping APCs of different types, sizes and mutual distances, we can investigate specific influences on magnetic and electrical transport properties.

TT 9: Superconductivity - Heterostructures, Andreev Scattering, Proximity Effect, Coexistence

Time: Monday 16:15–18:00 Location: H20

TT 9.1 Mon 16:15 H20

Nb Layers with Advanced Superconducting Properties as a Base for Proximity Effect Investigation. — •Anatolie Sidorenko[1,2], Vladimir Zdravkov[1], Andrei Prepelitsa[1], and Andrei Sudru[1] — [1]Institute of Electronic Engineering and Industrial Technologies ASM, MD-2028 Kishinev, Moldova — [2]3Institute of Nanotechnology, Forschungszentrum Karlsruhe, D-76021 Karlsruhe, Germany

High quality, large area Nb films (size 500 mm x mm) and constant thickness were deposited by DC magnetron sputtering in a commercial *Leybold Z400* vacuum system. Homogeneity and proper thickness of the Nb layer provided by the target-holder movement during the DC sputtering was achieved by using a specially constructed arrangement including a PC-controllable motor with gear. Rutherford backscattering spectrometry was used for precise thickness measurements. An increase of the superconducting parameters, i.e. the critical temperature rose more than 1.5 K and the superconducting coherence length was 30-35 % larger in comparison with the parameters for films with comparable thickness, which were prepared with common technique, was observed. The developed preparation technique for Nb films was used as a base for proximity effect investigation in layered S/F structures.

TT 9.2 Mon 16:30 H20

Spin-active scattering matrices for interfaces between superconductors and half metals — •Gero Bergner, Andreas Poenicke, Matthias Eschrig, and Gerd Schön — Institut für Theoretische Festkörperphysik und DFG-Center for Functional Nanostructures, Universität Karlsruhe, D-76128 Karlsruhe

Recently a non-vanishing supercurrent has been observed in a Josephson junction that contains an extended region of half-metallic CrO_2 between two singlet superconducting electrodes [1]. A theory to explain this phenomenon has been established in Refs. [2,3] that is formulated in terms of spin-active interface scattering matrices. Spin mixing and breaking of spin-rotation symmetry around the magnetization axis of the half metal are necessary ingredients for creation of equal spin triplet pairing amplitudes that can penetrate the half metal over a long range. Here, we present a microscopic model for a scattering matrix that exhibits such characteristics. We show that disorder of local magnetic moments at the interface between a superconductor and a ferromagnet with biaxial anisotropy in the interface region leads to the observed current conversion between singlet and equal spin triplet supercurrents. We discuss our results by comparing with the experimental findings of biaxial anisotropy and triplet supercurrents in the half metal CrO_2 [1].

[1] R.S. Keizer *et al.*,Nature **439**, 825-827(2006).
[2] M. Eschrig *et al.*,Phys. Rev. Lett. **90**, 137003 (2003).
[3] M. Eschrig *et al.*,cond-mat/0610212 (2006)

TT 9.3 Mon 16:45 H20

Superconducting spin valve structures grown on [Fe/V]-(001) superlattices — •Gregor Nowak[1], Kurt Westerholt[1], Moreno Marcellini[2], Andreas Liebig[2], Hartmut Zabel[1], and Björgvin Hjörvarsson[2] — [1]Experimentalphysik /Festkörperphysik, Ruhr - Universität Bochum — [2]Department of Physics, University of Uppsala, Sweden

In a superconducting F1/S/F2 epitaxial grown spin valve trilayer structure the superconducting V layer (S) is imbed in to two ferromagnetic Fe layers F1 and F2. Model calculations [1] based on the F/S proximity effect have shown that with suitable parameters for the thicknesses and correlations lengths of the F and S-layers the superconductivity can be switched off and on by rotating the magnetization of F1 and F2 from a parallel to an antiparallel orientation. Experimentally, however, it turned out to be quite difficult to optimize the F1/S/F2 device and until now only very small differences of the superconducting (SC) transition temperature (Tc) between the parallel and antiparallel orientation has been observed [2]. The epitaxial quality of the superconducting V-layer S reduces the impurity and surface scattering of the electrons to an extend that the SC correlation length becomes comparable to the V-film thickness, which is prerequisite for observing a definite SC spin valve effect. We clearly observe the SC spin valve effect with a difference in Tc for the ferromagnetic layers in the parallel or antiparallel orientation of up to 30 mK. References: [1] L. R. Tagirov, Phys. Rev. Lett. , 83, 2058, (1999) [2] J.Y. Gu, C.-Y. You, J. S. Jiang, and S. D. Bader, Phys. Rev. Lett. , 89, 267001, (2002)

Invited Talk TT 9.4 Mon 17:00 H20

Crossed Andreev Reflection in Superconductor-Ferromagnet Hybrid Structures — •Detlef Beckmann[1], Jakob Brauer[1], Dagmar Rall[1], and Hilbert v. Löhneysen[2,3] — [1]Forschungszentrum Karlsruhe, Institut für Nanotechnologie — [2]Forschungszentrum Karlsruhe, Institut für Festkörperphysik — [3]Physikalisches Institut, Universität Karlsruhe

We report on conductance measurements on multiterminal superconductor nanostructures, where two ferromagnetic or normal-metal leads form tunnel contacts to a single superconductor. The focus is on transport at energies below the superconducting gap, and length scales below the coherence length. We observe a negative non-local resistance which can be interpreted in terms of crossed Andreev reflection, a process where an electron incident from one of the leads gets reflected as a hole into the other, thereby creating a pair of spatially separated, entangled particles.

D. Beckmann, H.B. Weber and H.v. Löhneysen, Phys. Rev. Lett. **93**, 197003 (2004)
D. Beckmann and H.v. Löhneysen, cond-mat/0609766

TT 9.5 Mon 17:30 H20

Supercurrent through Semiconductor Quantum Wells in Parallel Magnetic Fields — •Franziksa Rohlfing[1], Thomas Geiger[1], Grigory Tkachov[2], Gustaaf Borghs[3], Christoph Strunk[1], and Dieter Weiss[1] — [1]Institut für Experimentelle und Angewandte Physik, Universität Regensburg, Germany — [2]Max-Planck-Institut für Physik komplexer Systeme, Dresden, Germany — [3]IMEC, Leuven, Belgium

We investigate the transport properties through narrow InAs bridges in a 4-point configuration within the two-dimensional electron gas (2DEG), that is formed in the InAs inversion layer. Superconductivity is proximity induced into the 2DEG by two sputterdeposited niobium stripes across the bridge. In this way a ballistic Josephson junction is formed within the 2DEG. The critical current of these junctions is measured as a function of perpendicular and parallel magnetic field. In a magnetic field perpendicular to the 2DEG the well-defined Fraunhofer pattern is observed. On the other hand, when the 2DEG is oriented parallel to the magnetic field, a monotonic decay of the critical current is observed. The measurement data can be explained within the framework of two models that discuss the effect of the Doppler shift or the Zeeman splitting on the Andreev bound states, respectively.

TT 9.6 Mon 17:45 H20

Ferromagnetic-superconducting heterostructures: Direct evidence for spin polarized quasiparticle self injection — •Soltan Soltan[1,2], Joachim Albrecht[3], Maerit Djupmyr[3], and Hanns-Ulrich Habermeier[1] — [1]Max–Planck–Institut für Festkörperforschung, Heisenbergstr. 1, D–70569 Stuttgart, Germany — [2]Physics Department, Faculty of Science, Helwan University, 11792-Helwan, Cairo, Egypt — [3]Max–Planck–Institut für Metalforschung, Heisenbergstr. 1, D–70569 Stuttgart, Germany

Epitaxial heterostructures of half–metal colossal magnetoresistive LCMO (HM–CMR) and high-T_c superconducting YBCO(HTSC) are grown on $SrTiO_3$(100) single crystal substrates by pulsed laser deposition. New transport R(T), magnetization M(T), and Hall effect measurements has been done. The R(T) shows an upturn at T = 30K to normal state resistance below the superconducting transition temperature T_c = 50K. This upturn in the resistance is matching with magnetization saturation M_s(T) for the same heterostructure. We explain our new results as a direct evidence for spin–polarized quasiparticle self injection.

TT 10: Superconductivity - Properties, Electronic Structure, Order Parameter

Time: Tuesday 9:30–13:00 Location: H18

TT 10.1 Tue 9:30 H18

Opening of the Superconducting Energy Gap observed with Neutron Spectroscopy — •Frank Weber[1,2], Andreas Kreyssig[3,4], Lothar Pintschovius[1], Winfried Reichardt[1], Oliver Stockert[5], Rolf Heid[1], Dmitry Reznik[1], and Klaudia Hradil[6] — [1]FZ Karlsruhe, IFP, Karlsruhe — [2]PI, Uni Karlsruhe (TH), Karlsruhe — [3]IFP, TU Dresden, Dresden — [4]Ames Laboratory, Ames, USA — [5]MPI-cpfs, Dresden — [6]IPC, Uni Göttingen, Aussenstelle FRM II, Garching

We present inelastic neutron scattering data on YNi_2B_2C ($T_c = 15$ K). We made a systematic study of the already known phonon anomaly in the (100)-direction [1] as well as of a so far unexplored anomaly at the zone boundary in the (110)-direction (M-point). Our data unambiguously show that the superconductivity-induced changes of the spectral function of phonons with a strong electron-phonon coupling can extremely well be understood in the framework of a theory proposed by Allen et al. [2]. The analysis yields the temperature dependent SC energy gap with high accuracy. As a consequence, even deviations from BCS like behavior can be assessed with confidence. Further, we found that the SC gap extracted from the phonon data for q=(0.5,0,0) and q=(0.5,0.5,0), respectively, differs by a factor 1.4. This is a direct proof for the long discussed anisotropy of the SC energy gap in borocarbides.

[1] Kawano et al., PRL. 77, 4628 (1996), [2] Allen et al., PRB 56, 5552 (1997)

TT 10.2 Tue 9:45 H18

Electron Spin Dynamics of the Novel Superconductor CaC_6 probed by ESR — •Ferenc Murányi, Grzegorz Urbanik, Vladislav Kataev, and Bernd Büchner — Leibniz Institute for Solid State and Materials Research Dresden, 01171 Dresden, PO BOX 270116, Germany

The Conduction Electron Spin Resonance (CESR) was measured on a thick slab of polycrystalline CaC_6 in the normal and superconducting state. The measurements characterize the metallic properties in the normal state and indicates the description of superconductivity in the dirty limit. Magnetic field dependent nonlinear absorption in the superconducting state evidenced the anisotropy of H_{c2}. Superconducting state measurements revealed the increase of effective skin depth below T_c.

TT 10.3 Tue 10:00 H18

Phonon anomalies in detwinned $YBa_2Cu_3O_{7-x}$: Strong *ab*-anisotropy in the phonon vibrations — •M. Bakr, C. Ulrich, J. Unterhinninghofen, D. Manske, C. Lin, and B. Keimer — Max-Planck-Institute for Solid State Research, Stuttgart, Germany

We have used Raman light scattering to investigate the electronic signal and phonon anomalies in detwinned optimally doped $YBa_2Cu_3O_{7-x}$ single crystals. Within the experimental error bar, no changes in the electronic gaps was observed with respect to the *a* and *b* axes. This is in contrast to previous experimental results observed by ARPES data and Josephson current measurements. All phonons show a pronounced asymmetry, i.e. Fano-profile, which indicates a strong electron-phonon interaction. A pronounced anisotropy in the asymmetry is observed with respect to the crystallographic *a* and *b* axes. This anisotropy appears for example for the 340 cm^{-1} phonon, but the 501 cm^{-1} phonon shows the largest difference. It is interesting to note that this phonon is right at the energy of the $2\Delta_{max}$ gap. The anisotropy of the asymmetry parameter, 1/q, is already present in the normal state. Below T_c, the 1/q changes drastically and in a characteristic way for the *a* and *b* axes. Finally, we compare our results with Fermi-liquid based calculations. Our results provide further insight into the electron-phonon interaction and therefore the electronic system of high T_c superconductors.

TT 10.4 Tue 10:15 H18

Theory for ultrafast dynamics in cuprates: Role of electron-phonon coupling — •Julia Unterhinninghofen[1], Dirk Manske[1], and Andreas Knorr[2] — [1]Max-Planck-Institut für Festkörperforschung, Heisenbergstr. 1, 70569 Stuttgart — [2]Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin

We present a theory for ultrafast nonequilibrium dynamics in cuprate superconductors. In a typical time-resolved spectroscopy experiment, the sample is exited with an intense laser pulse, creating nonequilibrium quasiparticles which subsequently can relax via various scattering processes, restoring the superconducting state. We use the method of density matrix theory to study the optical excitation and relaxation dynamics in cuprates from a microscopical viewpoint. In particular, we consider scattering with optical phonons, looking at the interplay between relaxation of the excited quasiparticles and the creation of nonequilibrium phonon distributions; the superconducting state is restored on a 10 picosecond timescale, while the phonons have longer relaxation times. Time-resolved pump-probe spectra are calculated and compared both to quasi-equilibrium models and experimental results.

TT 10.5 Tue 10:30 H18

Charge(re)distribution at YBCO/metal interfaces: screened band bending — •Cosima Schuster and Udo Schwingenschlögl — Institut für Physik, Universität Augsburg, 86135 Augsburg

The functionality of nanoscale devices depends crucially on the transport properties across the interfaces. Especially, the transport mechanism in electronic devices based on high-T_c-superconductors is of special interest, in particular the charge density within the superconducting CuO_2 planes in the vicinity of an interface or grain boundary. Main questions in this context are interface charging, band bending, or contact resistivity. We calculate the local electronic structure of an YBCO/metal interface using density functional theory (using the Wien2k code) in two different geometries (where the interface is either parallel or perpendicular to the CuO_2 planes), including an optimization of the atomic positions near the interface. We consider supercells with 4 metal and 2 YBCO or 6 metal and 3 YBCO units, respectively. For the parallel contact we find a transfer of holes out of the CuO_2 planes resulting in shift to the underdoped regime of the high-T_c phase diagram. Thus, this geometry reflects the properties of a grain boundary. The results are neither dependent on contact geometry, nor the contact metal, or interface plane.

TT 10.6 Tue 10:45 H18

First principles Thermodynamics of $YBa_2Cu_3O_7$ — Volker Pankoke[1,2], •Rolf Heid[1], and Klaus-Peter Bohnen[1] — [1]Forschungszentrum Karlsruhe, Institut für Festkörperphysik — [2]Forschungszentrum Karlsruhe, Institut für Wissenschaftliches Rechnen

Modern density-functional based methods nowadays allow for an accurate calculation of phonon spectra and their dependence on structural parameters, which is a prerequisite for the study of finite temperature properties based on the free energy. Due to the large numerical costs, however, ab initio studies of thermodynamic properties have been restricted in most cases to crystals with simple lattice structures.

We will present an application of this ab initio approach to the cuprate superconductor $YBa_2Cu_3O_7$ with its rather complex crystal structure. Thermodynamical properties are calculated within the quasiharmonic approximation using phonon spectra obtained by density functional perturbation theory. We will discuss results for the anisotropic thermal expansion and specific heat in comparison with experiment to assess the accuracy of this approach.

TT 10.7 Tue 11:00 H18

Terahertz spectroscopy of electron-doped superconductors in magnetic field — •Artem V. Pronin[1], Andrei Pimenov[2,3], Alois Loidl[2], Akio Tsukada[4,5], and Micho Naito[4] — [1]Hochfeld-Magnetlabor Dresden (HLD), Forschungszentrum Dresden-Rossendorf, 01314 Dresden, Germany — [2]Experimentalphysik V, EKM, Universität Augsburg, 86135 Augsburg, Germany — [3]Experimentelle Physik 4, Universität Würzburg, 97074 Würzburg, Germany — [4]Department of Applied Physics, Tokyo University of Agriculture and Technology, 2-24-16, Naka-cho, Koganei, Tokyo 184-8588, Japan — [5]NTT Basic Research Laboratories, NTT Corporation, 3-1 Morinosato-Wakamiya, Atsugi, Kanagawa 243-0198, Japan

In the terahertz and infrared regions we measured the optical conductivity and penetration depth of the electron-doped cuprate superconductor $La_{2-x}Ce_xCuO_4$. In the frequency-temperature behavior of conductivity we observe remarkable differences between the samples with different Ce content, suggesting the gap anisotropy to be a func-

tion of the doping level.

At terahertz frequencies, we performed measurements in high magnetic fields to suppress superconductivity below Tc. From the conductivity spectra we extract the quasiparticle scattering rate as a function of temperature, and compare its behavior in the superconducting and normal states below T_c. We find a small but measurable optical magnetoresistance at all doping levels, and no signatures for the pseudogap. We also discuss the applicability of "universal scaling laws"to our data on conductivity and penetration depth.

15 min. break

TT 10.8 Tue 11:30 H18

Charge modulation driven Fermi surface of Pb-Bi2201 — •Lenart Dudy, Beate Müller, Alica Krapf, Helmut Dwelk, Ralf-Peter Blum, Christoph Janowitz, and Recardo Manzke — Institut f. Physik, Humboldt-Universität zu Berlin, Newtonstr. 15, 12489 Berlin

Due to doping with lead it is well known that the about (1x5) superstructure of Bi cuprate superconductors will be suppressed. Nevertheless, a Fermi surface map of $Bi_{2-y}Pb_ySr_{2-x}La_xCuO_{6+\delta}$ with x = 0.4 and y = 0.4 determined by angular resolved photoemission (ARPES) revealed additional Fermi surface (FS) features. Here a La content of x = 0.4 means optimum hole doping for a maximum value of Tc and for a Pb amount of y = 0.4 one commonly expect complete suppression of the superstructure. Low energy electron diffraction of these samples showed no sign of a superstructure. Scanning tunnelling microscopy, on the other hand, revealed directly two modulations of the electron density of much weaker amplitude, one long-range modulation of about (1x32) periodicity and a second of about (12x12). By taking into account the wave vectors and intensities of these two modulations the corresponding Fermi surface has been simulated, which agrees strikingly good with the experimental one. The occurrence of modulations in these high-Tc superconductors will be further discussed.

TT 10.9 Tue 11:45 H18

Energy dependence of excitations near the Fermi surface in Bi(Pb)-2212 and Bi(Pb)-2201 — •B. Müller, L. Dudy, H. Dwelk, A. Krapf, C. Janowitz, and R. Manzke — Humboldt Universität Berlin, Institut für Physik, Newtonstr. 15, 12489 Berlin

In Bi derived HT_c-cuprates the question of how many excitations occur near the Fermi surface is not yet completely answered. There are hints that more than the two peaks derived from bilayer-splitting are hidden in the well-known peak-dip-hump structure [1,2]. In our group it was previously argued that an additional polarisation dependent double-peak structure arises in the one- and two-layer Bi-cuprate [2]. In Bi(Pb)-2201 this can be traced unequivocally since there are no superstructure or bilayer effects possibly concealing this excitation. In Bi(Pb)-2212 the intensity ratio of the peak-dip-hump structure is energy dependent which could be a tool to uncover split excitations [1]. In this contribution the photon energy dependence of the excitations near the Fermi energy of Bi(Pb)-2212 and Bi(Pb)-2201 is studied.

[1] A.A. Kordyuk, S.V. Borisenko, T.K. Kim, K.A. Nenkov, M. Knupfer, J. Fink, M.S. Golden, H. Berger, R. Follath, Phys. Rev. Lett. 89 (2002) 077003

[2] R. Manzke, R. Müller, C. Janowitz, C. Ast, H. Höchst, Phys. Rev. B 63 (2001)R 100504; C. Janowitz, R. Müller, L. Dudy, A. Krapf, R. Manzke, C. Ast, H. Höchst, Europhys. Lett. 60 (2002) 615

TT 10.10 Tue 12:00 H18

STM local strucuture analysis of Pb-Bi2201 depending on the lead content — •Olaf Lübben, Ralf-Peter Blum, Lenart Dudy, Alica Krapf, Helmut Dwelk, Christoph Janowitz, and Recardo Manzke — Institut f. Physik, Humboldt-Universität zu Berlin, Newtonstr. 15, 12489 Berlin

With scanning tunneling microscopy (STM) we have performed a detailed and systematic structural analysis of optimally lanthanum doped single-layered bismuth cuprates, $Bi_{2-y}Pb_ySr_{2-x}La_xCuO_{6+\delta}$ ($x = 0.4$), as a function of the Pb content. As expected, the periodicity of the well-known (5×1) superstructure varies with increasing the amount of Pb. For about $y = 0.4$ the superstructure is almost suppressed but, unexpectedly, new modulations occur in the electron density which might influence the electronic properties of these cuprates. In addition, this could affect the charge transfer between the carrier reservoir (BiO-SrO) and the CuO_2 plane as suggested for Pb-Bi2212 by Shi et al.[1].

[1] L. Shi et al., J. Phys.: Condens. Matter 13, 5195 (2001)

TT 10.11 Tue 12:15 H18

Magnetic field dependence of the superconducting gap node topology in non-centrosymmetric $CePt_3Si$ — •Ilya Eremin[1,2] and James Annett[3] — [1]Max-Planck-Institut für Physik Komplexer Systeme,D-01187, Dresden, Germany — [2]Institute für Mathematische und Theoretische Physik, Technische Universität Carlo-Wilhelmina zu Braunschweig, 38106 Braunschweig, Germany — [3]H.H. Wills Physics Laboratory, University of Bristol, Tyndall

Non-centrosymmetric superconductors, such as $CePt_3Si$ and Li_2PtB_2, are believed to have a line node in the energy gap arising from coexistence of s-wave and p-wave pairing. Using as an example $CePt_3Si$ we show that a weak c-axis magnetic field will remove this line node, since it has no topological stability against time-reversal symmetry breaking perturbations. Conversely a field in the $a-b$ plane is shown to remove the line node on some regions of the Fermi surface, while bifurcating the line node in other directions, resulting in two 'boomerang'-like shapes. These line node topological changes are predicted to be observable experimentally in the low temperature heat capacity.

TT 10.12 Tue 12:30 H18

Thermodynamic and Transport Properties of the Noncentrosymmetric Superconductor LaBiPt — •Gernot Goll[1], Michael Marz[1], Andreas Hamann[1], Tihomir Tomanic[1], Kai Grube[2], T. Yoshino[3], and T. Takabatake[3] — [1]Physikalisches Institut, Universität Karlsruhe, 76128 Karlsruhe — [2]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, 76021 Karlsruhe — [3]Hiroshima University, Higashi-Hiroshima, Japan

Noncentrosymmetric superconductors have attracted considerable interest in recent years. The lack of an inversion center of the crystal lattice makes unconventional pairing symmetries feasible. Even mixed superconducting states consisting of singlet and triplet states are possible. We report on the observation of superconductivity in the half-Heusler compound LaBiPt which crystallizes in the noncentrosymmetric cubic space group $F\bar{4}3m$. The crystal structure is composed of three fcc sublattices for Pt, Bi, and La with the relative atomic coordinates (0,0,0), (1/4,1/4,1/4), and (3/4,3/4,3/4), respectively. LaBiPt becomes superconducting below $T_c \approx 0.9\,\mathrm{K}$ as evidenced from measurements of the resistivity, magnetisation and specific heat. In view of a simplified BCS model $T_c \sim T_\mathrm{D} \exp\left(-(N(0)V)^{-1}\right)$ where $N(0) \sim m^* n^{1/3}$ is the electronic density of states at the E_F, T_D is the Debye temperature, and V is the effective, attractive potential, is surprisingly high because LaBiPt is a semimetal with very low charge-carrier concentrations $n = 6 \cdot 10^{18}\,\mathrm{cm}^{-3}$. The carrier concentration is still 1-2 orders of magnitude lower than in the classical low-carrier-density superconductors GeTe and SnTe and comparable to that found in $SrTiO_3$.

TT 10.13 Tue 12:45 H18

Ginzburg-Landau theory of superconducting surfaces under electric fields — Pavel Lipavsky[1], •Klaus Morawetz[2,3], Jan Kolacek[4], Ernst Helmut Brandt[5], and Tzong Jer Yang[6] — [1]Faculty of Mathematics and Physics, Charles University, Ke Karlovu 3, 12116 Prague 2, Czech Republic — [2]Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany — [3]Max Planck Institute for the Physics of Complex Systems, Noethnitzer Str. 38, 01187 Dresden, Germany — [4]Institute of Physics, Academy of Sciences, Cukrovarnická 10, 16253 Prague 6, Czech Republic — [5]Max Planck Institute for Metals Research, D-70506 Stuttgart, Germany — [6]Department of Electrophysics, National Chiao-Tung University, Hsinchu 300, Taiwan

A boundary condition for the Ginzburg-Landau wave function at surfaces biased by a strong electric field is derived within the de Gennes approach. This condition provides a simple theory of the field effect on the critical temperature of superconducting layers. [Phys. Rev. B 73 (2006) 052505-1-5]

TT 11: Quantum Impurities, Kondo Physics

Time: Tuesday 9:30–12:15 Location: H19

TT 11.1 Tue 9:30 H19

Simultaneous ferromagnetic and semiconductor-metal transition in EuO — Michael Arnold and •Johann Kroha — Physikalisches Institut, Nussallee 12, 53115 Bonn

We develop a theory for the simultaneous para-to-ferromagnetic and semiconductor to metal transition in O-depleted EuO. An analysis of the total charge conservation across the transition indicates that strong Coulomb correlations in the localized O-defect states must play a crucial role. This leads to a generalized Anderson impurity model with Stoner-like magnetic correlations in the conduction band and a dilute concentration of Anderson impurities in the semiconducting gap. We solve this model using a self-consistent Non-Crossing Approximation.

TT 11.2 Tue 9:45 H19

Random Kondo alloys — •Sebastien Burdin and Peter Fulde — Max-Planck-Institut fur Physik komplexer Systeme, Nothnitzer Strasse 38, 01187 Dresden, Germany

The interplay between the Kondo effect and disorder is studied. This is done by applying a matrix coherent potential approximation (CPA) and treating the Kondo interaction on a mean-field level. The resulting equations are shown to agree with those derived by the dynamical mean-field method (DMFT). By applying the formalism to a Bethe tree structure with infinite coordination the effect of diagonal and off-diagonal disorder are studied. Special attention is paid to the behavior of the Kondo- and the Fermi liquid temperature as function of disorder and concentration of the Kondo ions. The non monotonous dependence of these quantities is discussed.

TT 11.3 Tue 10:00 H19

Dephasing rate due to diluted Kondo impurities — Tobias Micklitz[2], Alexander Altland[2], •Theodoulos Costi[1], and Achim Rosch[2] — [1]Institut für Festkörperforschung, Forschungszentrum Jülich, 52425 Jülich — [2]Institut für Theoretische Physik, Universität zu Köln, 50937 Köln

We calculate the dephasing rate, $1/\tau_\varphi$, of electrons due to magnetic impurities in a weakly disordered metal as measured in a weak-localization experiment. For sufficiently low impurity concentrations, n_S, the dephasing rate is a universal function, $1/\tau_\varphi = (n_S/\nu) f(T/T_K)$, of T/T_K, where T_K is the Kondo scale and ν is the density of states [1,2]. Recent measurements of the dephasing rate due Fe impurities in Ag wires with $T_K = 4.3K$ [3] are shown to be well described by the above universal function for the fully screened Kondo model calculated with the numerical renormalization group method. Purely underscreened or overscreened Kondo impurities are ruled out for explaining the experiments, although a small fraction of underscreened Kondo impurities (sitting at lower symmetry sites, for example) might account for the observed slower than predicted decay of the dephasing rate at the lowest temperatures measured, $T < 0.1T_K$.

[1] T. Micklitz et al., Phys. Rev. Lett. **96**, 226601 (2006).
[2] T. Micklitz et al., cond-mat/0610304 (2006).
[3] F. Mallet et al., Phys. Rev. Lett. **97**, 226804 (2006).

TT 11.4 Tue 10:15 H19

2-channel Kondo behavior in quantum defects with partially broken SU(3) symmetry — •Tobias Langenbruch, Michael Arnold, and Johann Kroha — Physikalisches Institut, Universität Bonn, Germany

We propose an atomic rotational state defect embedded in a metal as a microscopic model to realize the 2-channel Kondo (2CK) effect. The model has a partially broken SU(3) symmetry, where the excited states of the bare defect are doubly degenerate due to space inversion symmetry.

Using perturbative renormalization group techniques we show that for a wide range of parameters this model has a stable two-channel Kondo fixed point. The stability is due to a correlation-induced crossing of the local levels. The energy dependence of the renormalized coupling functions is crucial for this stabilization.

We calculate the differential conductance of quantum point contacts with such defects, exhibiting spikes at elevated bias voltages due to fluctuations into excited local levels. We discuss the various energy scales involved in this system as well as the asymmetrical spike shape and conjecture that this model may provide a microscopic explanation for the longstanding puzzle of both, the 2CK signatures and the conductance spikes observed by Ralph and Buhrman [1] in ultrasmall quantum point contacts.

[1] D.C. Ralph and R. A. Buhrman, PRL 69, 2118 (1992); PRB 51, 3554 (1995).

TT 11.5 Tue 10:30 H19

Transmission through a two-level quantum dot — •Theresa Hecht[1], Christoph Karrasch[2], Andreas Weichselbaum[1], Yuval Oreg[3], Jan von Delft[1], and Volker Meden[2] — [1]Department für Physik, CeNS und Arnold Sommerfeld Center, Ludwig-Maximilians Universität München — [2]Institut für Theoretische Physik, Universität Göttingen — [3]Department of Condensed Matter Physics, The Weizmann Institute of Science, Israel

Measurements of the transmission phase shift of many-electron quantum dots revealed a "universal" phase behavior with phase lapses of π between consecutive resonances, whereas for dots with only a few electrons the phase behaves "mesoscopically" [1]. These generic features were reproduced in [2] for a spinless many-level Anderson model (AM) in the limits of $\delta/\Gamma \ll 1$ (universal) and $\delta/\Gamma \gg 1$ (mesoscopic), where δ is the mean level spacing, Γ the mean level width. Inspired by the experiment and based on [2], we now extend the studies to a many-level spinfull AM by means of Wilson's numerical renormalization group method and investigate the temperature dependence of the transmission through the quantum dot.

[1] M. Avinun-Kalish, M. Heiblum, O. Zarchin, D. Mahalu, V. Umansky, Nature 436, 529 (2005)
[2] C. Karrasch, T. Hecht, Y. Oreg, J. von Delft, and V. Meden (2006), cond-mat/0609191

15 min. break

TT 11.6 Tue 11:00 H19

Transconductance in a double quantum dot system in the Kondo regime — •Verena Koerting[1], Jens Paaske[2], and Peter Wölfle[1] — [1]Institut fuer Theorie der Kondensierten Materie, Universitaet Karslruhe, 76128 Karlsruhe, Germany — [2]The Niels Bohr Institute, University of Copenhagen, 2100 Copenhagen, Denmark

We consider a system of two lateral quantum dots in a spin 1/2 state, each contacted by two leads, and mutually coupled by spin exchange interaction K. The coupling to the leads is modeled by exchange tunneling (coupling J). We calculate the currents through both quantum dots as a function of the two bias voltages $V_{L,R}$ in renormalized perturbation theory in coupling functions $J(\omega)$, preserving the non-equilibrium physics at large voltages by taking into account the frequency dependence of the couplings. For sufficiently large antiferromagnetic K the groundstate of the double dot is a spin singlet. Since electron transport through e.g. the left dot requires triplet excitations we find a threshold in the differential conductance $G_L = dI_L/dV_L$ as a function of bias voltage V_L, with $G_L \approx 0$ if $eV_L \ll K$ and if the right dot is at low bias voltage $eV_R \ll K$. For increasing eV_R approaching K the triplet states get occupied and G_L rises rapidly. We will calculate this *transconductance* signal and show that Kondo correlations will significantly enhance dI_L/dV_R around $eV_R \approx K$. An outlook on experimental realization of this *quantum transistor* will be given.

TT 11.7 Tue 11:15 H19

The Kondo model in nonequilibrium: Decoherence, current, and noise — Thomas Korb[1], •Frank Reininghaus[1], Herbert Schoeller[1], and Jürgen König[2] — [1]Institut für Theoretische Physik A, RWTH Aachen, 52056 Aachen, Germany — [2]Institut für Theoretische Physik III, Ruhr-Universität Bochum, 44780 Bochum, Germany

We study the Kondo effect in nonequilibrium using the real-time renormalization group [1] and put special emphasis on the calculation of the decoherence rate Γ. We obtain expressions for the current and the finite-frequency noise which are valid for voltages $V \gg T_K$. While the decoherence rate cannot be detected by measuring the current in a two-terminal setup, which was calculated previously using other methods [2,3], we demonstrate that the frequency dependence of the noise has features which allow the identification of Γ.

[1] H. Schoeller and J. König, Phys. Rev. Lett. **84**, 3686 (2000)

[2] A. Rosch *et al.*, Phys. Rev. Lett. **90**, 076804 (2003)
[3] S. Kehrein, Phys. Rev. Lett. **95**, 056602 (2005)

TT 11.8 Tue 11:30 H19

A time-dependent Numerical Renormalization Group Analysis of Single Molecule Magnets — •David Roosen[1], Maarten Wegewijs[2], and Walter Hofstetter[1] — [1]Institut für Theoretische Physik, J. W. Goethe-Universität, D-60438 Frankfurt, Germany — [2]Institut für Theoretische Physik A, RWTH Aachen, D-52056 Aachen, Germany

It has recently become possible to perform experiments where single molecule magnets (SMMs), which exhibit a large intrinsic spin, are attached to metallic leads and electronic transport is measured [1]. Motivated by this, a simple quantum impurity model describing SMMs was studied theoretically and it was found that the anisotropy energies dramatically change the Kondo effect observed in such systems, even making a complete screening of the magnetic degrees of freedom possible [2].

We have investigated the *time-dependent* Kondo effect in a single molecule magnet strongly coupled to metallic electrodes, with a sudden perturbation at time $t = 0$. We use a generalization of the Numerical Renormalization Group for nonequilibrium situations [3]. Applying this method to a Kondo model with large spin $S > 1/2$ we systematically analyze the underscreening of the local moment and the effects of anisotropy terms on the real-time dynamics of the magnetization.

[1] H. Heersche et al. , Phys. Rev. Lett. **96**, 206801 (2006)
[2] C. Romeike, M. R. Wegewijs, W. Hofstetter and H. Schoeller, Phys. Rev. Lett. **96**, 196601 (2006)
[3] F. Anders and A. Schiller, Phys. Rev. Lett. **95**, 196801 (2005)

TT 11.9 Tue 11:45 H19

Matrix product state approach for a two-lead Anderson model — •Andreas Holzner[1,2], Andreas Weichselbaum[1], and Jan von Delft[1] — [1]LMU München, Lehrstuhl für Theoretische Festkörperphysik, Theresienstraße 37, D-80333 München, Germany — [2]Institut für Theoretische Physik C, RWTH Aachen, D-52056 Aachen, Germany

Both NRG and DMRG can be formulated using the matrix product state (MPS) formalism. Using this common basis, we apply DMRG techniques to the Anderson model after mapping the leads to Wilson-chains as in NRG. For calculating the ground state properties this method proves to be more efficient and more flexible than NRG. In this sense more complex systems are accessible. Specifically, we map a two-lead Anderson model onto a quasi-1-dimensional star geometry upon which we sweep similar in style to 1-site finite-size DMRG. We present results for the groundstate occupation of a spinful 4-level quantum dot.

TT 11.10 Tue 12:00 H19

Sum-rule Conserving Spectral Functions from the Numerical Renormalization Group — •Andreas Weichselbaum and Jan von Delft — Ludwig-Maximilians-Universität, Arnold Sommerfeld Center, 80333 München

We show how spectral functions for quantum impurity models, i.e. nanosystem embedded in fermionic or bosonic environment, can be calculated very accurately using a complete set of *discarded* numerical renormalization group (NRG) eigenstates, recently introduced by Anders and Schiller. The only approximation is to judiciously exploit energy scale separation. Our rigorous derivation avoids both the overcounting ambiguities and the single-shell approximation for the equilibrium density matrix prevalent in current methods including state of the art DM-NRG. The resulting procedure based on the full density matrix of the system (FDM-NRG) ensures that relevant sum rules hold rigorously and spectral features at energies below the temperature can be described accurately.

TT 12: Symposium "Coated HTS Conductors"

Time: Tuesday 9:30–13:00 Location: H20

Invited Talk TT 12.1 Tue 9:30 H20

Improvement of the Critical Current Density in YBCO Coated Conductors — •Bernhard Holzapfel — IFW Dresden, Helmholtzstr. 20, 01069 Dresden

The Jc limitation mechanism in coated conductors based on biaxially textured metal substrates depends strongly on the applied magnetic field. Up to a texture dependent crossover field, the network of small angle grain boundaries limits Jc. Below this crossover field Jc can be improved by optimizing the grain boundary network. At higher magnetic fields above the crossover field, Jc is limited by the intragrain pinning properties. Here we report on different material aspects connected to the Coated Conductor to improve the overall critical current density. Based on optimized cube textures in recrystallized metal tapes and appropriate buffer layer architectures, Jc of coated conductors at lower magnetic fields can be improved by geometrically tailoring the grain boundary network using cube textured substrates with high aspect ratio grains. For higher magnetic fields, where the intragrain pinning properties limit Jc, our experiments to introduce artificial pinning centres by preparation of quasi-multilayers where sub unit cell thin metal layers were incorporated in Y123 films will be discussed. Due to the oxidizing deposition atmosphere and solid state reaction with the Y123 phase nanometre sized perovskite precipitates, which are epitaxially incorporated into the Y123 lattice, are formed. Pinning properties and Jc anisotropy at various fields and temperatures were analyzed. At 77K irreversibility fields up to 10.3T were observed in Y123 quasi-multilayers containing nano-sized BaHfO3 precipitates.

TT 12.2 Tue 10:00 H20

A Reel to Reel MOCVD process for Coated Conductors — •Oliver Stadel[1], Ruslan Muydinov[1], Jürgen Schmidt[1], Hartmut Keune[1], Georg Wahl[1], Sergej Samoilenkov[2], Andrej Blednov[2], Georgy Dosovitskiy[2], Oleg Gorbenko[2], and Andrey Kaul[2] — [1]Institut für Oberflächentechnik, TU Braunschweig, Bienroder Weg 53, 38108 Braunschweig — [2]Moscow Department of Chemistry, State University V 234, Moscow,119 899, Russia

A MOCVD process for contiuous deposition of YBCO and oxide buffer layers on long metal tapes was developed. Texured Ni alloyed tapes were coated with oxide buffer layers at low oxygen partial pressure without oxidation of the metal tape. 350-1000 nm thick YBCO films were deposited at a tape velocity of 4 m/h. MOCVD buffer layers and additional samples, which were delivered from partners of the Virtual Institute, were used. The YBCO films on chemically coated buffer layers exhibit 0.3-7 MA/cm2 at 77 K. On PVD coated buffer layers the critical current density was 1-2 MA/cm2. The excellent in plane texture (FWHM = 5-6°) and out of plane texture (FWHM = 1.4-3°) of the YBCO films on chemically coated buffer layers may enable to increase further the critical current density.

Acknowledgement: The authors thank the partners of the Virtual Institute Chemically deposited YBCO Superconductors. We acknowledge the financial support by Ministry of Science and Culture of Lower Saxony and the European Community in frame of the ESF/EFRE project SuperConTech and the Helmholtz Gemeinschaft e.V. for financial support.

TT 12.3 Tue 10:15 H20

The potential of Roebel assembled coated conductor cables — •Curt Schmidt — Forschungszentrum Karlsruhe, Institut für Technische Physik, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen

Low ac-loss HTS cables for transport currents well above 1 kA are required for application in transformers and generators and are taken into consideration for future generations of fusion reactor coils. Coated conductors (CC) are suitable candidates for high field application at an operation temperature in the range 50-77 K, which is a crucial precondition for economical cooling costs. We prepared a short lengths of Roebel bar cables made from industrial DyBCO-CC (Theva Company, Germany) and YBCO-CC (Superpower). Meander shaped tapes of 4 (5) mm width with twist pitches of 122 (180) mm were cut from the 10 (12) mm wide CC tapes using a specially designed tool. Eleven or sixteen of these strands were assembled to a cable. The electrical and mechanical connection of the tapes was achieved using a silver powder filled conductive epoxy resin. Ac losses of a short sample in an external

ac field were measured as a function of frequency and field amplitude in transverse and parallel field orientations as well as the coupling current time constant in transverse field. The potential of this cable type for ac-use is discussed with respect to ac-losses and current carrying capability.

15 min. break

TT 12.4 Tue 10:45 H20

Limitation of fault current in power grids using YBCO coated conductors — •Wolfgang Schmidt[1], Hans-Peter Krämer[1], Heinz-Werner Neumüller[1], Urs Schoop[2], Alex Malozemoff[2], and Alex Otto[2] — [1]Siemens AG, Corporate Technology, Erlangen, Deutschland — [2]American Superconductor Corporation, Westborough (MS), USA

Resistive type superconducting fault current limiters (FCL) utilize a current-driven transition from the superconducting state to the normal state to limit short circuit currents in electric power grids. The FCL needs not triggering and recovers automatically after the short circuit has been opened. The technical performance of superconducting fault current limiters has been demonstrated within numerous successful projects worldwide. Since the advent of commercial second generation (2G) high temperature superconductor wires based on YBCO thin films, also the economic feasibility comes into reach. We have investigated the fault current limiting performance of 344 superconductors stabilized with stainless steel sheets supplied by American Superconductor Corporation within a co-operation with Siemens Corporate Technology. Bifilar coils have been manufactured and tested with a typical limitation period of 50 ms under stepwise increasing voltage loads to determine the maximum temperature the wires can withstand without degradation. Several coils have been assembled into a limiter model to demonstrate uniform tripping of the individual coils and fast recovery with few seconds. Test results of single coils and of the coil assembly are presented and further developments will be discussed.

TT 12.5 Tue 11:00 H20

Switching and Quench Propagation in Coated Conductors for Fault Current Limiters — •Helmut Kinder[1], Jörg Handke[1], Werner Prusseit[1], Andrej Kudymow[2], Christian Schacherer[2], and Mathias Noe[2] — [1]THEVA Dünnschichttechnik GmbH, Ismaning — [2]ITP, Forschungszentrum Karlsruhe

We address the use of coated conductors for resistive fault current limiters. Fast quench propagation is essential to let the conductor switch on the full length within milliseconds. The ordinary thermal quench propagation mechanism, however, is too slow because of the small heat diffusivity in typical tape substrate materials. Here we present a new mechanism involving a propagating instability of the superconductor made possible by the particular conductor design. The instability is based on current bunching leading to overcritical current densities and does not rely upon thermal conductivity. It leads to a rapid spreading of the resistive state so that the conductor develops its full normal resistance in a millisecond. Thus the conductor protects itself without the need of thick normal conducting stabilizers that would reduce the current limiting efficiency. The mechanism was confirmed by numerical simulations and by experiments on samples of short and medium length. Conductor lengths of 1 m and more switched homogeneously exhibiting voltage drops of up to 2.7 V/cm.

TT 12.6 Tue 11:15 H20

Nexans Advances in all CSD Route for REBCO Coated Conductors — Joachim Bock, Juergen Ehrenberg, Bernhard Hoppe, Dirk Isfort, Marcel Klein, and •Mark Rikel — Nexans SuperConductors, Chemiepark Knapsack, Huerth 50351, Germany

Development of REBCO coated conductors (CC) at Nexans SuperConductors (NSC) is focused on all chemical solution deposition (CSD) route that promises the best performance-to-price ratio in long lengths. The feasibility of all CSD approach is shown on the lab scale: using metalorganic deposition (MOD), NSC was able to produce YBCO/CeO_2/LZO/NiW CCs with J_c(77 K, sf) = 0.5 MA/cm^2. The major advance of NSC on a semi-industrial scale is the use of MOD route for production of high-quality $La_2Zr_2O_7$ (LZO) coated NiW RABITS in lengths up to 12 m. With those substrates, it is possible to produce CCs with the simplest (one-buffer) architecture by depositing REBCO using other techniques (ISD at Theva, Ismaning; MOCVD at IOT, Braunschweig; HLPE at University of Cambridge, UK). The best short sample I_c = 280, 120 and 100 A/cm-width for HLPE, ISD, and MOCVD, respectively First long-length conductors show transport I_c = 40 A (10m-long, ISD). Further work is focused on optimisation of the already established mixed (MOD+PVD) approaches, understanding optimum architecture and processing conditions for the all-CSD route and developing tools for scaling those conditions to long-length production.

The work is supported in part by BMBF (SupraNanoSol, ForOxid) and EU (HiperChem, Super3C).

TT 12.7 Tue 11:30 H20

Temperature series to study the biaxial texturing of $La_2Zr_2O_7$ buffer layers on nickel-tungsten substrates — •Leopoldo Molina[1], Sebastian Engel[2], Bernhard Holzapfel[2], and Oliver Eibl[1] — [1]Institute of Applied Physics, University of Tübingen, Auf der Morgenstelle 10, D-72076, Tübingen, Germany — [2]IFW Dresden, P.O.Box 270116, D-01171 Dresden, Germany

$La_2Zr_2O_7$(LZO) buffer layers are currently of great interest for $YBa_2Cu_3O_{7-x}$(YBCO) coated conductor technology. The mechanism of biaxial texturing of the film was investigated by varying the annealing temperature. The LZO buffer layers were prepared by chemical solution deposition (CSD) and annealed at temperatures ranging from 600°C to 1000°C in order to study the growth, biaxial-texture and microstructure of the LZO thin films. Nanovoids of 10-50 nm were found to be a typical feature of the buffer layers. Samples were investigated by transmission electron microscopy (TEM) and x-ray diffraction (XRD). Diffraction contrast imaging and convergent beam electron diffraction (CBED) techniques were used to investigate the microstructure of the films in plan-view and cross-section. XRD measurements showed that LZO grain growth starts at T>800°C. The average Ni grain size of the biaxially textured nickel tungsten substrates is $40\mu m$ and the grain size of the LZO buffer layers is 100-200 nm. Thus, even though the films are highly biaxially textured, no epitaxial growth occurs.

15 min. break

TT 12.8 Tue 12:00 H20

The pyrolysis of $YBa_2Cu_3O_{7-\delta}$ thin films produced by metal-organic deposition using trifluoroacetic acid-based precursors — •Thomas Thersleff[1], Sebastian Engel[1], Martina Falter[1], Brigitte Schlobach[1], Kerstin Knoth[1], Ludwig Schultz[1,2], and Bernhard Holzapfel[1] — [1]Leibniz IFW-Dresden, Postfach 270116, 01171 Dresden, Germany — [2]Dresden University of Technology, Department of Physics, D-01062 Dresden, Germany

To assist with the optimization of the TFA-MOD process for $YBa_2Cu_3O_{7-\delta}$ coated conductor development, this work examines the pyrolysis stage - in which organic constituents are burned off - on both single crystal as well as buffered nickel substrates. Samples were dip-coated into precursor solutions prepared using metal acetates as well as $YBa_2Cu_3O_{7-\delta}$ powder dissolved in trifluoroacetic acid and placed in a flowing gas furnace with a humid O_2 atmosphere. While firing, individual samples were quenched at various temperatures, effectively freezing the pyrolysis development. These samples were then analyzed for phase formation using grazing incidence x-ray diffraction; surface morphology using AFM; decomposition reactions using TGA, DTA, and exhaust gas characterization; and stoichiometry using EDX. Additionally, cross-sectional cuts were made in the pyrolyzed layers with a FIB, facilitating a detailed discussion of the layer morphology. Results indicate that significant layer shrinkage occurs between 200 and 250 °C and reveal a large surface tension. BaF_2 crystallizes above 270 °C while CuO forms above 200 °C. FIB results suggest that HF gas evolves above 200 °C but is trapped within the layer until 270 °C.

TT 12.9 Tue 12:15 H20

Artificial pinning centers in $YBa_2Cu_3O_{7-x}$ thin films created by nanoparticles from the gas phase — •Maria Sparing, Elke Backen, Thomas Freudenberg, Jörg Acker, Ruben Hühne, Ludwig Schultz, Bernd Rellinghaus, and Bernhard Holzapfel — IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

The critical current density in $YBa_2Cu_3O_{7-x}$ (YBCO) thin films, which limits their application in high magnetic fields, can be enhanced by the introduction of artificial pinning centers as, e.g., provided by nanoparticles. An inert gas phase condensation process was used to prepare Y_2O_3 nanoparticles from an yttrium target by DC magnetron sputtering. With this method, both the size distribution and the areal density of the particles as determined from TEM investigations are

independently controlled during deposition. Particles with a mean diameter of about 8 nm were deposited on $SrTiO_3$ substrates, which are terminated by TiO_2 through etching with BHF solution and subsequent annealing in 1 atm O_2 at 900°C. The behavior of the particles on the substrate at varying temperatures in an O_2 atmosphere of 0,7 mbar (YBCO deposition conditions) was studied by AFM and ICP-MS. A 300 nm thin $YBa_2Cu_3O_{7-x}$ layer was deposited onto the likewise precoated substrates by off-axis pulsed laser deposition. Both inductive and resistive transport measurements at 77K in magnetic fields of up to 9 T reveal the influence of the particles on the superconducting properties of $YBa_2Cu_3O_{7-x}$.

TT 12.10 Tue 12:30 H20

Development of conductive buffer architectures based on IBAD-TiN — •Ruben Hühne, Martin Kidszun, Konrad Güth, Ludwig Schultz, and Bernhard Holzapfel — IFW Dresden, Institute for Metallic Materials, P.O. Box 270116, D-01171 Dresden, Germany

Ion beam assisted deposition (IBAD) offers the possibility to prepare thin textured films on amorphous or non-textured substrates. It was shown within the last decade that thin cube textured MgO and TiN layers can be produced on amorphous or nanocrystalline seed layers using this technique. Especially the results on the in-plane textured growth of TiN are promising for the development of a conducting buffer layer architecture for YBCO coated conductors based on the IBAD approach. Therefore, IBAD-TiN layers have been deposited on Si/Si_3N_4 as well as on polished Hastelloy tapes using pulsed laser deposition. Different metallic buffer layers as Au or Ir were grown epitaxially on top of the TiN layer showing similar texture values as the IBAD layer. Finally, biaxially textured YBCO layers were achieved using a conductive oxide cap layer. Detailed measurements of the structural and superconducting properties will be presented.

TT 12.11 Tue 12:45 H20

Improved pinning in $YBa_2Cu_3O_{7-x}$ based quasi-multilayers prepared by off-axis pulsed laser deposition — •Elke Backen, Karolin Tscharntke, Sebastian Engel, Ruben Hühne, Ludwig Schultz, and Bernhard Holzapfel — IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

Higher in-field J_c values of thin $YBa_2Cu_3O_{7-x}$ (YBCO) films due to pinning at artificial pinning centers are of great interest for the development and improvement of coated conductors. It is possible to enhance the pinning forces in YBCO by introducing nanosized particles into the films using quasi-multilayers of YBCO and a transistion metal (Hf, Zr, Ir) by on-axis pulsed laser deposition [1,2]. In order to improve reproducibility, off-axis PLD was used to prepare YBCO/Hf multilayers. Due to the oxidizing deposition atmosphere and solid state reaction with the YBCO phase, nanometre sized perovskite precipitates, that are biaxially textured with a well-defined relationship towards the YBCO lattice were formed. Pinning properties and the J_c anisotropy were characterized using magneto-transport measurements at various fields and temperatures. A significant improvement of J_c as well as irreversibility field B_{irr} could be observed in the off-axis deposited quasi-multilayers.

[1] Hänisch et al. Appl. Phys. Lett. 86 (2005) 122508.
[2] Hänisch et al. Supercond. Sci. Technol. 19 (2006) 534-540.

TT 13: Symposium "Superconductivity and Magnetism in Lamellar Cobaltates"

Time: Tuesday 14:00–17:50 Location: H18

Invited Talk TT 13.1 Tue 14:00 H18

Angle-resolved photoemission studies on Na_xCoO_2 — •Hong Ding — Boston College, Chestnut Hill, MA, USA

In this talk I will report a systematic angle-resolved photoemission study of Na_xCoO_2 single crystals for a wide range of Na concentrations. We observed a large Fermi surface centered at the Γ point, which satisfies Luttinger counting theorem when x ¡ 0.75. The small Fermi surface pockets predicted by LDA band calculations near the K points are not observed. Instead, "sinking islands"with the binding energy of 50 - 200 meV are observed. All of these, along with a large band renormalization, may be caused by the strong correlations in this material. In addition, at x = 1/3 where superconductivity occurs with proper water intercalation, we found that the large Fermi surface coincides with the new zone boundary of a commensurate charge ordering, suggesting that the charge fluctuations may play an important role in the superconductivity of this material.

Invited Talk TT 13.2 Tue 14:30 H18

Phase diagram and in-plane spin fluctuation in the novel superconducting system Na_xCoO_2 * y H_2O — •Kazuyoshi Yoshimura — Department of Chemistry, Graduate School of Science, Kyoto University, Kyoto 606-8502, Japan

Recent studies on the physical and chemical properties of the bilayer hydrated (BLH) triangular lattice superconductor Na_xCoO_2 * y H_2O have revealed the fact that the superconductivity would occur near the ferromagnetic electron correlations. We newly synthesized the non-superconducting and superconducting BLH Na_xCoO_2 * y H_2O compounds by the systematic sample preparation with time-controlling duration effect in high humidity atmosphere. As a result, we succeeded in constructing the electronic phase diagram as a function of the ^{59}Co NQR frequency, and found that superconducting phase exists very closely to the non-superconducting magnetic BLH phase in the vicinity of quantum critical point of magnetic correlations. These results strongly suggests that the superconductivity in BLH Na_xCoO_2 * y H_2O originates from the ferromagnetic fluctuation within the CoO_2 layer. This result is also supported by the results of $1/T_1$ of ^{23}Na NMR which can be explained by a part of the A-type fluctuations observed in the mother compound Na_xCoO_2. We will give a review of the physical and chemical properties of the exotic and anisotropic superconducting BLH compound, Na_xCoO_2 * y H_2O.

This work was done as collaborations with Hiroto Ohta, Chishiro Michioka, Yutaka Itoh, Yoshihiko Ihara and Kenji Ishida from Kyoto University.

TT 13.3 Tue 15:00 H18

Cooper-pair symmetry and spin correlations in the cobaltate superconductors Na_xCoO_2 * 1.3 H_2O — •Guo-qing Zheng — Okayama University, Okayama 700-8530, Japan

We will present NMR/NQR results on the symmetry of the Cooper pairs in the superconducting state and the spin correlations in the normal state of Na_xCoO_2 * 1.3 H_2O. We find that below T_c the spin-lattice relaxation rate ($1/T_1$), decreases in proportion to T^3 and down to very low temperature, strongly suggesting line nodes in the gap function [1,2]. The spin susceptibility measured via the Knight shift decreases below T_c in all directions [3]. These results indicate anisotropic, spin-singlet, (e.g., d-wave), pairing. In the normal state, the data point to antiferromagnetic spin correlations in the CoO_2 plane. We will also discuss the Na-content and pressure dependencies of the spin correlations and the superdconducting properties. This work was done in collaboration with K. Matano (Okayama U), R.L. Meng, J. Cmaidalka, C.W. Chu (Houston U), D.P. Chen and C.T. Lin (Max Plank Institute, Stuttgart).

[1] T. Fujimoto et al, Phys. Rev. Lett. 92, 047004 (2004). [2] G. - q. Zheng et al, J. Phys.: Condens. Matter 18, L63 (2006). [3] G. - q. Zheng et al, Phys. Rev. B73, 180503 (R) (2006).

15 min. break

TT 13.4 Tue 15:40 H18

Magnetic phase separation in highly Na doped Na_xCoO_2 with x > 0.75. — •Christian Bernhard[1], Li Yu[1], Alexander Boris[2], Dapeng Chen[2], Chengtian Lin[2], Bernhard Keimer[2], and Christof Niedermayer[3] — [1]Universität Fribourg, Chemin du Musee 3, CH-1700 Fribourg, Switzerland — [2]Max-Planck-Insitut für Festkörperforschung, Heisenbergstrasse 1, D-70569 Stuttgart, Germany — [3]Paul-Scherrer-Institut, CH-5232 Villigen-PSI, Switzerland

We report muon spin rotation and infrared ellipsometry measurements on Na_xCoO_2 single crystals with 0.75<x<1 that provide evidence for an intrinsic phase separation scenario. At the highest Na content of x=0.97 we observe isolated magnetic clusters which have a small total spin of about S=1 and undergo a spin freezing transition around

$T_{sf} \sim 20$ K. With decreasing Na content the cluster begin to overlap developing extended antiferromagnetic patches with T_N=22 K. A bulk long-range ordered state occurs near x=0.75. The optical data establish a highly anomalous charge transport with signatures of a strong spin charge coupling which is explained in terms of a hole doping induced spin state transition of the Co^{3+} ions.

TT 13.5 Tue 16:05 H18

Magnetic properties of spin-orbital polarons in lightly doped cobaltates — •Maria Daghofer, Peter Horsch, and Giniyat Khaliullin — MPI for Solid State Research, Stuttgart, Germany

We present a numerical treatment of a spin-orbital polaron model for Na_xCoO_2 at small hole concentration ($0.7 < x < 1$). We demonstrate how the polarons account for the peculiar magnetic properties of this layered compound: They explain the large susceptibility; their internal degrees of freedom lead both to a negative Curie-Weiss temperature and yet to a ferromagnetic intra-layer interaction, thereby resolving a puzzling contradiction between these observations. We make specific predictions on the momentum and energy location of excitations resulting from the internal degrees of freedom of the polaron, and discuss their impact on spin-wave damping.

TT 13.6 Tue 16:30 H18

Magnetic ordering and excitations in Na_xCoO_2 — •Sibel Bayrakci[1], Isabelle Mirebeau[2], Philippe Bourges[2], Yvan Sidis[2], Mechthild Enderle[3], Joel Mesot[4], Dapeng Chen[1], Cheng-tian Lin[1], and Bernhard Keimer[1] — [1]Max-Planck-Institut für Festkörperforschung, Stuttgart — [2]Laboratoire Léon Brillouin, C.E.A./C.N.R.S., Gif-sur-Yvette, France — [3]Institut Laue-Langevin, Grenoble, France — [4]Laboratory for Neutron Scattering, ETH Zurich & Paul Scherrer Institute, Villigen, Switzerland

Superconductivity in the layered cobalt oxide $Na_xCoO_2{:}yH_2O$ ($x \sim 0.30$, $y \sim 1.4$) is the subject of intensive current investigation. This material is particularly interesting given its structural similarity to the high-T_c copper oxide superconductors, with the added attribute of triangular symmetry. The unhydrated parent compound Na_xCoO_2 is itself intriguing due to its exceptionally high thermopower over the range $0.5 \leq x \leq 0.9$, which occurs in unusual combination with low resistivity and low thermal conductivity. Na_xCoO_2 has been shown to exhibit bulk antiferromagnetic order below ~ 20 K for $0.75 \leq x \leq 0.9$. In neutron scattering experiments on the composition with $x = 0.82$, we have observed Bragg reflections which correspond to A-type antiferromagnetic order and characterized the corresponding three-dimensional spin wave dispersion. The in- and out-of-plane exchange constants resulting from a fit to a simple Heisenberg model are similar in magnitude, which is unexpected given the layered crystal structure of Na_xCoO_2. Possible explanations will be discussed. Recent inelastic measurements on the $x = 0.5$ composition will also be mentioned.

15 min. break

TT 13.7 Tue 17:10 H18

Superconducting epitaxial thin films of $Na_xCoO_2 \cdot yD_2O$: A route to new experiments — Yoshiharu Krockenberger[1,2], Ingo Fritsch[2], Philipp Komissinskiy[1], Georg Christiani[2], Hanns-Ulrich Habermeier[2], and •Lambert Alff[1] — [1]Institute for Materials Science, TU Darmstadt — [2]Max-Planck-Institute for Solid State Research, Stuttgart

We report on the fabrication of epitaxial thin films of sodium cobaltate [1] and describe a way how to intercalate water in these films in order to obtain superconductivity [2]. The epitaxial thin films are grown using pulsed laser deposition. We suggest a growth model for the hexagonal layered sodium cobaltate on the square lattice of the $SrTiO_3$ substrates. While these results are in themselves an achievement of advanced thin film technology, the availability of epitaxial thin films opens the way for improved and new experiments with $Na_xCoO_2 \cdot yD_2O$. While improved surface quality enhances the possibility of surface sensitive measurements, thin films also allow for the fabrication of Josphson and tunnel junctions to study the superconducting order parameter.

These work is supported by the Deutsche Forschungsgemeinschaft (project Al560/6).

[1] Y. Krockenberger, I. Fritsch, G. Christiani, A. Matveev, L. Alff, H.-U. Habermeier, and B. Keimer, Appl. Phys. Lett. **86**, 191913 (2005).

[2] Y. Krockenberger, I. Fritsch, G. Christiani, H.-U. Habermeier, Li Yu, C. Bernhard, B. Keimer, and L. Alff, Appl. Phys. Lett. **88**, 162501 (2006).

TT 13.8 Tue 17:35 H18

Electronic theory for itinerant in-plane magnetic fluctuations and many-body correlations in Na_xCoO_2 — •Maxim Korshunov[1,2], Ilya Eremin[1,3], Alexey Shorikov[4], and Vladimir Anisimov[4] — [1]Max-Planck-Institut für Physik komplexer Systeme, D-01187 Dresden, Germany — [2]L.V. Kirensky Institute of Physics, Siberian Branch of Russian Academy of Sciences, 660036 Krasnoyarsk, Russia — [3]Institute für Mathematische und Theoretische Physik, TU Braunschweig, 38106 Braunschweig, Germany — [4]Institute of Metal Physics, Russian Academy of Sciences-Ural Division, 620041 Yekaterinburg GSP-170, Russia

Based on the *ab-initio* band structure for $Na_xCoO_2 \cdot yH_2O$ we derive the single-electron energies and the effective tight-binding description for the t_{2g} bands using projection procedure. Due to the presence of the next-nearest-neighbor hoppings a local minimum in the electronic dispersion close to the Γ point of the first Brillouin zone forms. Correspondingly, in addition to a large Fermi surface an electron pocket close to the Γ point emerges at high doping concentrations. The latter yields the new scattering channel resulting in a peak structure of the itinerant magnetic susceptibility at small momenta. This indicates dominant itinerant in-plane ferromagnetic fluctuations above certain critical concentration x_m, in agreement with neutron scattering data. Below x_m the magnetic susceptibility shows a tendency towards the antiferromagnetic fluctuations. We further analyze the many-body effects on the electronic and magnetic excitations using various approximations applicable for different U/t ratio.

TT 14: Spin Systems and Itinerant Magnets

Time: Tuesday 14:00–19:15 Location: H19

TT 14.1 Tue 14:00 H19

Static and Dynamic Properties of an [Fe_{13}] Cluster — •Joris van Slageren[1], Patrick Rosa[2], and Andrea Caneschi[3] — [1]1. Physikalisches Institut, Universität Stuttgart — [2]ICMCB, CNRS, Pessac, France — [3]INSTM, UdR Firenze, University of Florence, Italy

The static and dynamic magnetic properties of an [Fe_{13}] cluster were investigated using several experimental techniques. The cluster crystallizes in a cubic space group, but careful investigation of the crystallographic data revealed that the symmetry is distorted locally. DC magnetic susceptibility measurements showed the presence of competing antiferromagnetic isotropic exchange interactions leading to a high-spin ground state and many low-lying excited spin states, which was confirmed by inelastic neutron scattering measurements. From high-field electron paramagnetic resonance measurements a small zero-field splitting of the spin ground state was inferred, which supports the local symmetry distortion found in the crystallographic studies. The spin dynamics slows down at sub-kelvin temperatures, where ac susceptibility measurements indicated that part of the sample shows superparamagnetic-like behavior and the other part relaxes through magnetization tunneling. The Mössbauer data confirmed the slowing down of the spin dynamics, indicating that this occurs mainly in the peripheral spins.

TT 14.2 Tue 14:15 H19

Hall effect and magnetoresistance in weakly ferromagnetic $CeSi_x$ and heli-magnetic MnSi — Andreas Neubauer[1], Christian Pfleiderer[1], Philipp Niklowitz[1], Robert Ritz[1], •Peter Böni[1], Dmitri Souptel[2], and Günter Behr[2] — [1]Physik Department E21, Technische Universität München, D-85748 Garching, Germany — [2]IFW Dresden, PF 270116, D-01171, Dresden, Germany

We report a comparison of the magnetoresistance and Hall effect in single crystals of the easy-plane ferromagnet $CeSi_x$ ($x \approx 1.81$) with that

observed in the helical magnet MnSi. In $CeSi_x$ the anomalous Hall effect clearly tracks the ordered moment as function of temperature and magnetic field. It may be used as a simple means to establish the presence of a ferromagnetic quantum phase transition under pressure. The behavior seen in ferromagnets $CeSi_x$ is contrasted by anomalous contributions to the Hall effect in MnSi, which suggest an important scale of order 100K. Further, in MnSi only subtle differences in the temperature dependences of the Hall effect near a quantum phase transition may be expected. We compare a conventional analysis in the framework of additive charge carrier relaxation rates with the more recent proposal of additive currents.

TT 14.3 Tue 14:30 H19

Magnetic excitations in multiferroic $TbMnO_3$ — •Daniel Senff[1], Peter Link[2], Klaudia Hradil[3], Arno Hiess[4], Louis Pierre Regnault[4], Yvan Sidis[5], Nadir Aliouane[6], Dimitri Argyriou[6], and Markus Braden[1] — [1]II. Physikalisches Institut, Universität zu Köln — [2]Forschungsneutronenquelle FRM II, TU München — [3]Institut für Physikalische Chemie, Universität Göttingen — [4]Institut Laue-Langevin, Grenoble / France — [5]Laboratoire Leon Brillouin, Saclay / France — [6]Hahn-Meitner-Institut, Berlin

Ferroelectricity (FE) in $TbMnO_3$ is intimately coupled to a complex magnetic ordering: The existence of a spontaneous electric polarization is closely correlated with a magnetic transition into an incommensurable spin-spiral structure. The critical excitations at the FE-transition are thus no longer of phononic, as in conventional ferroelectrics, but of magnetic origin.

We present extensive neutron scattering studies on the spin-wave spectrum of $TbMnO_3$ in the para- as well as in the ferroelectric phase [1]. We have identified the different magnon branches of the spiral structure and discus the dispersion, the field and the temperature dependence of the modes most relevant for the FE-transition. Comparing with recent optical experiments we find an excellent agreement and strengthen the interpretation of strongly mixed magnon-phonon excitations, called electromagnons, as proposed by Pimenov et al. [2].

[1] D. Senff et al., cond-mat/0610620, submitted to PRL.

[2] A. Pimenov et al., Nature physics **2** (2005) 97.

TT 14.4 Tue 14:45 H19

Modelluntersuchungen zum Phasendiagramm multiferroischer Manganite — •Jens Wohlgemuth und Gertrud Zwicknagl — Institut für Mathematische Physik, Technische Universität Braunschweig, Braunschweig

Es werden die Grundzustände eines Modell-Hamilton-Operators zur Beschreibung von $R\mathrm{MnO_3}$ (R=Tb, Dy, Gd) diskutiert. Als Modell wird das zweifachentartete Doppel-Austausch-Modell mit antiferromagnetischer Kopplung zwischen benachbarten t_{2g} Spins verwendet. Dieses wird um die Dzyaloshinskii-Moriya-Wechselwirkung erweitert, die durch das Brechen der Inversionssymmetrie eine makroskopische elektrische Polarisation erzeugen kann. Die mögliche Grundzustände werden zunächst in Molekularfeldnäherung bestimmt. Dabei wird die kinetische der e_g-Bandelektronen exakt behandelt. Das Auftreten von Phasenseparation wird untersucht. Schließlich werden Quantenkorrekturen zur klassischen Rechnung diskutiert.

Invited Talk TT 14.5 Tue 15:00 H19

Topological phases in condensed matter — •Roderich Moessner — Theoretical Physics, Oxford University

Topological phases currently play an important role in condensed matter physics. Most saliently, they are associated with various spectacular phenomena, such as the fractional quantum Hall effect or, with less confidence, high-temperature superconductivity. In addition, they are central to the attempt to construct a quantum computer protected against decoherence by a topological mechanism. Finally, they widen our understanding of the possible states of matter, as their description lies beyond the classial Landau-Ginzburg–Wilson framework of phases and phase transitions. This talk provides an overview of some of these issues, together with a presentation of recent developments. It focuses on the role that magnetic lattice systems can play in elucidating the physics of topological phases.

15 min. break

TT 14.6 Tue 15:45 H19

Static Holes in the Geometrically Frustrated Bow-Tie Ladder — •Wolfram Brenig[1] and George Martins[2] — [1]Institut für Theoretische Physik, Technische Universität Braunschweig, D-38106 Braunschweig, Germany — [2]Department of Physics, Oakland University, Rochester, MI 48309, U.S.A.

Doping of the geometrically frustrated bow-tie spin ladder with static holes is investigated by a complementary approach using exact diagonalization and hard-core quantum dimers. Results for the thermodynamics in the undoped case, the singlet density of states, the two-hole energy and the spin correlations will be presented. We find that the static holes polarize their vicinity by a localization of singlets in order to reduce the frustration. As a consequence the singlet polarization cloud induces short range repulsive forces between holes with oscillatory longer range behavior, which may lead to deconfinement. For those systems we have studied, most results for the quantum dimer approach agree qualitatively if not quantitatively with exact diagonalization. The ground state of the undoped system is non-degenerate with translationally invariant nearest-neighbor spin correlations up to the largest systems studied, consistent with a spin liquid state or a valence bond crystal with very large unit cell.

TT 14.7 Tue 16:00 H19

Strongly correlated fermions on frustrated lattices — •Frank Pollmann[1], Kirill Shtengel[2], Peter Fulde[1], and Erich Runge[3] — [1]Max–Planck–Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, 01187 Dresden, Germany — [2]Department of Physics, University of California, Riverside, CA 92521, USA — [3]Technische Universität Ilmenau, Institut für Physik, 98684 Ilmenau, Germany

Systems with frustrated interactions are generally characterized by a high density of low–lying excitations which leads to a high susceptibility and thus interesting physical effects. The study of frustrated spin systems has revealed numerous fascinating properties, e.g., the realization of liquid phases and an enhanced magnecaloric effect. We focus on charge degrees of freedom on geometrically frustrated lattices. In particular, we study a novel class of strongly correlated fermions which could allow for a possibility of fractionally charged excitations. For a model of strongly correlated spinless fermions on a planar pyrochlore (checkerboard) lattice it has been shown that fractional charges are linearly confined. We consider now a model of spinful fermions on a geometrically frustrated kagome lattice at particular filling factors. Of special interest is again the strongly correlated limit where excitations which carry a fractional charge are possible. An effective Hamiltonian is derived which describes the low–lying excitations. We study the interplay between charge– and spin–degrees of freedom by means of exact diagonalization. In particular we show that the ground state is charge and spin ordered.

TT 14.8 Tue 16:15 H19

Correlated spinless fermions on a checkerboard lattice — •Olga Sikora, Frank Pollmann, and Peter Fulde — Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, 01187 Dresden, Germany

Possible fractionalization of quantum numbers on frustrated lattices has recently attracted a lot of interest. In particular, it has been suggested that charge fractionalization might occur in a model of strongly correlated spinless fermions on a planar pyrochlore (checkerboard) lattice.

We consider a quarter– and half–filled checkerboard lattice in the limit of strong nearest–neighbor interactions V ($V \gg |t|$, where t is a hopping integral). The low–energy excitations are described by an effective Hamiltonian which is given to the lowest non-vanishing order by ring exchange around hexagons. A gauge transformation allows to remove the fermionic sign problem and the system can be described by an effective bosonic model. We use the Green's function Monte Carlo method to study the quantum mechanical ground state of the effective Hamiltonian. The method is verified by a comparison with the results for small clusters obtained by exact diagonalization method.

TT 14.9 Tue 16:30 H19

Resonant Inelastic X-ray Scattering at the O 1s Resonance of Transition Metal Monoxides — •Thorsten Schmitt[1], Laurent Duda[2], Vladimir Strocov[1], Martin Magnuson[2], Johan Forsberg[2], Anders Olsson[2], Joseph Nordgren[2], Kozo Okada[3], and Akio Kotani[4] — [1]Swiss Light Source, Paul Scherrer Institut, Villigen PSI, Switzerland — [2]Department of Physics, Uppsala University, Uppsala, Sweden — [3]The Graduate School of Natural Science and Technology, Okayama University, Okayama, Japan — [4]RIKEN/Spring8, Hyogo, Japan

Resonant inelastic x-ray scattering (RIXS) is a powerful tool for determining the energy and symmetry of charge neutral electronic excitations in strongly correlated materials. We report on high-resolution polarization-dependent RIXS at the O 1s resonance of NiO [1], CoO and MnO. The experimental results are compared to multi-site cluster calculations, which are able to describe collective excitations. Tuning the incident X-ray energy to the first absorption peak excites the O 1s electron into empty O 2p states strongly hybridized with the metal 3d states. Thus the de-excitation process reveals contributions from low-energy excitations mediated by the O 1s core-hole. Apart from local oxygen ligand to metal charge transfer excitations and local crystal field excitations, the O 1s RIXS spectra give also rise to non-local metal-to-metal charge transfer excitations and double inter-site spin flip excitations (double-singlet creation).

[1] L.-C. Duda, T. Schmitt, M. Magnuson et al., Phys. Rev. Lett. 96, 067402 (2006).

TT 14.10 Tue 16:45 H19

Study of magnetic ordering in $YTi0_3$ using high-resolution dilatometry — •William Knafo[1,2], Christoph Meingast[1], Alexander Boris[3], Paul Popovich[3], Natalia Kovaleva[3], Petar Yordanov[3], Andrei Maljuk[3], Bernhard Keimer[3], and Hilbert v. Löhneysen[1,2] — [1]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, D-76021 Karlsruhe — [2]Physikalisches Institut, Universität Karlsruhe, D-76128 Karlsruhe — [3]Max-Planck-Institute for Solid State Research, Heisenbergstrasse 1, D-70569 Stuttgart

The perovskite $YTi0_3$ orders ferromagnetically below $T_C = 26.7$ K, whereas $LaTiO_3$ orders antiferromagnetically below $T_N = 150$ K. The origin of this difference is currently being strongly debated and is related to the different types of lattice distortions, e.g. to the $GdFe0_3$-type distortion and to the Jahn-Teller distortion induced by the orbital ordering in these systems [1-5]. We present here a study of the macroscopic distortions associated with magnetic ordering in $YTi0_3$ using thermal expansion and magnetostriction measurements. The uniaxial pressure dependencies of the Curie temperature T_C and of the low temperature ferromagnetic moment are extracted from our data. The coupling of magnetism to the different kinds of distortion (i.e. of $GdFe0_3$- and Jahn-Teller-type) will be discussed.

[1] Ulrich et al., Phys. Rev. Lett. 89, 167202, (2002).
[2] Iga et al., Phys. Rev. Lett. 92, 176403, (2004).
[3] Akimitsu et al., J. Phys. Soc. Jpn. 70, 3475 (2001).
[4] Pavarini et al., New J. Phys. 7, 188 (2005).
[5] Mochizuki and Imada, New J. Phys. 6, 154 (2004).

TT 14.11 Tue 17:00 H19

Ordering and spin waves in vanadium spinels — •Natalia Perkins[1] and Olga Sikora[2] — [1]Technische University of Braunschweig, Braunschweig, Mendellsohnstrasse 3,38106, Germany — [2]Max Planck Institute for Complex System, Noethnitzer Str.38, Dresden, 01187, Germany

We consider the effect of quantum spin fluctuation on the ground state properties of spin-orbital Hamiltonian on a pyrochlore lattice, which is derived to model the ground state properties of vanadium spinel oxides AV_2O_4 (A=Zn, Mg, Cd). As the magnitude of the spin-orbit interaction and that of the exchange one are very similar, both interactions should be simultaneously considered. We show that the low-energy effective Hamiltonian decides about the magnetic interactions of the system and determines the ground state. We also find that the magnetic excitation spectrum obtained by linear spin-wave approach in case of quenched orbital angular momentum differs significantly from one calculated in the magnetic exciton model formulated for the case with unquenched orbital angular momentum. Thus we suggest that the performance of the neutron scattering experiment would help to clarify both the overall picture of the ground state and of the excitation spectrum.

TT 14.12 Tue 17:15 H19

Magnetic properties of the layered cobaltates $La_{2-x}Sr_xCoO_4$ — •N. Hollmann, M.W. Haverkort, M. Benomar, M. Reuther, T. Lorenz, and J.A. Mydosh — II. Physikalisches Institut, University of Cologne

This talk presents a study on the magnetic properties of the layered perovskite $La_{2-x}Sr_xCoO_4$. This class of materials crystallises in the K_2NiF_4 structure as the high-T_C superconductors $La_{2-x}Sr_xCuO_4$ or the corresponding nickelates $La_{2-x}Sr_xNiO_4$, the latter exhibiting stripe order of both charge and spin. In many cobaltates, the spin state of the cobalt ions is an extra degree of freedom. The non-layered compound $LaCoO_3$ even shows a thermally driven spin-state transition. Much less is known about the spin states of the cobalt ions in $La_{2-x}Sr_xCoO_4$. We prepared a series of single crystals by the floating zone method, covering a strontium doping range of $0.3 \leq x \leq 0.8$. We measured the magnetic susceptibility for a magnetic field applied parallel and perpendicular to the CoO_2 planes. We find a clear deviation from Curie-Weiss behaviour and strong anisotropy. From the direction of the magnetic anisotropy we conclude that χ is dominated by Co^{2+} in the high-spin state, while Co^{3+} is in the low-spin state. These findings are confirmed by full-multiplet crystal field calculations which show that spin-orbit coupling and crystal field effects are essential for describing the magnetic behaviour.

Supported by the DFG through SFB 608

15 min. break

TT 14.13 Tue 17:45 H19

Orbitally Ordered Phase in $Ca_{2-x}Sr_xRuO_4$ Investigated with Resonant X-ray Diffraction — •Ioannis Zegkinoglou[1], Joerg Strempfer[2], Britta Bohnenbuck[1], Christie S. Nelson[3], John P. Hill[3], Jonathan C. Lang[4], George Srajer[4], Yoshiteru Maeno[5], and Bernhard Keimer[1] — [1]Max-Planck-Institut für Festkörperforschung, Stuttgart, Germany — [2]HASYLAB at DESY, Hamburg, Germany — [3]Brookhaven National Laboratory, New York, USA — [4]APS at Argonne National Laboratory, Argonne, USA — [5]Department of Physics, Kyoto University, Japan

Resonant x-ray diffraction at the Ru L_{II} and L_{III} absorption edges was used to investigate the interplay between the spin, lattice and orbital degrees of freedom in the layered 4d-electron $Ca_{2-x}Sr_xRuO_4$ system [1]. A new orbital ordering phase transition was discovered in single-crystal compounds with Sr-doping x=0 and x=0.1 at temperatures 260 K and 130 K, respectively, at reciprocal space positions (100) and (011). The orbital order is only weakly coupled to the lattice. Its propagation vector is not affected by the change of the low-temperature antiferromagnetic structure upon Sr substitution. The tilt order of the RuO_6 octahedra was also probed in our studies. It produces resonant scattering at the structurally and magnetically forbidden (110) position and follows a different temperature dependence from orbital order.

[1] I. Zegkinoglou et al., Phys. Rev. Lett. 95, 136401 (2005)

TT 14.14 Tue 18:00 H19

Magnetism in single-layered Ruthenates — •Paul Steffens[1], Olaf Schumann[1], Yvan Sidis[2], Peter Link[3], Satoru Nakatsuji[4], and Markus Braden[1] — [1]II. Physikalisches Institut, Universität Köln, 50937 Köln — [2]Laboratoire Léon Brillouin, Gif-sur-Yvette, France — [3]FRM II, Technische Universität München, 85747 Garching — [4]Institute of Solid State Physics, Tokyo, Japan

We present recent results on the magnetism in the single-layered ruthenates $Ca_{2-x}Sr_xRuO_4$. Depending on the Sr-content x, very different properties are observed. In this contribution we focus on the region $0.2 < x < 0.5$. Here, the system is metallic and paramagnetic, but close to magnetic order, and a competition of a ferromagnetic and incommensurate antiferromagnetic instability determines the magnetic behaviour. An applied magnetic field induces a drastic change; we have studied this metamagnetic transition by inelastic neutron scattering, thereby probing the dynamic magnetic correlations at different magnetic fields and temperatures. We find that the ground state without magnetic field is determined by a near nesting instability of the Fermi surface. A magnetic field higher than the metamagnetic critical field suppresses these features and induces strong paramagnon scattering, proving the existence of strong ferromagnetic correlations.

TT 14.15 Tue 18:15 H19

Investigation of Magnetic and Orbital Order in $Ca_3Ru_2O_7$ using Resonant X-ray Diffraction — •Britta Bohnenbuck[1], Jörg Strempfer[2], Ioannis Zegkinoglou[1], Christie Nelson[3], and Bernhard Keimer[1] — [1]Max Planck Institute for Solid State Research, Heisenbergstrasse 1, 70569 Stuttgart, Germany — [2]HASYLAB at DESY, Notkestrasse 85, 22605 Hamburg, Germany — [3]National Synchrotron Light Source, Brookhaven National Laboratory, Upton, New York 11973-5000, USA

We used resonant x-ray diffraction at the L_{II}- and L_{III}- absorption edges of Ru to investigate the bilayered transition metal oxide $Ca_3Ru_2O_7$. This system shows metallic antiferromagnetism between the metal to insulator transition T_{MI}=48K and the antiferromagnetic

ordering temperature T_N=56K. In order to learn more about the magnetic and orbital degrees of freedom we performed azimuthal and polarization studies on high quality single crystals both below and above T_{MI} at various reciprocal space positions. Our results are consistent with the magnetic structure proposed by neutron experiments. The magnetic moments are coupled ferromagnetically within the ab-planes but antiferromagnetically between adjacent planes. We also observe a reorientation of the magnetic moment in the ab-plane at T_{MI}. This coincides with a drastic intensity decrease of the magnetic reflection, which vanishes completely at T_N. Our diffraction studies do not give any indication for antiferroorbital order in $Ca_3Ru_2O_7$. However, there might be ferroorbital order as proposed recently by Raman spectroscopy.

TT 14.16 Tue 18:30 H19

Characterization and electronic structure calculations of the antiferromagnetic insulator Ca_3FeRhO_6 — •Volker Eyert[1], Udo Schwingenschlögl[1], Raymond Fresard[2], Antoine Maignan[2], Christine Martin[2], Ninh Nguyen[2], Christian Hackenberger[3], and Thilo Kopp[3] — [1]Institut für Physik, Universität Augsburg, 86135 Augsburg — [2]Laboratoire CRISMAT, UMR CNRS-ENSICAEN(ISMRA) 6508, 14050 Caen Cedex, France — [3]Zentrum für Elektronische Korrelationen und Magnetismus, Institut für Physik, Universität Augsburg, 86135 Augsburg

We investigate the antiferromagnetic insulating nature of Ca_3FeRhO_6 both experimentally and theoretically. Susceptibility measurements reveal a Néel temperature of $T_N \simeq 20\,\mathrm{K}$, and an effective magnetic moment of $5.3\mu_B$ per formula unit. Mössbauer spectroscopy strongly suggests that the Fe ions, located at trigonal prismatic sites, are in a 3+ high spin state. Transport measurements display a simple Arrhenius law, with an activation energy of $\sim 0.2\,\mathrm{eV}$. The experimental results are interpreted with LSDA band structure calculations, which confirm the Fe^{3+} state, the high-spin/low-spin scenario, the antiferromagnetic ordering, and the value for the activation energy.

TT 14.17 Tue 18:45 H19

Electronic structure of the spin chains in $(Ca,Sr)_{14}Cu_{24}O_{41}$ — •Cosima Schuster and Udo Schwingenschlögl — Institu für Physik, Universität Augsburg, 86135 Augsburg

The incommensurate composite systems $(Ca,Sr)_{14}Cu_{24}O_{41}$ are based on three largely independent subsystems, Cu_2O_3 ladders, CuO_2 chains, and electron donor ions. We focus on the electronic properities of the chain subsystem. The crystal structure of the Ca and Sr-rich compound differ in a symmetric or asymmetric alignment of the CuO_2 chains. Substitution of Sr by Ca leads to a transfer of holes from the chains to the ladders. The spin order on the chains likewise depends strongly on the doping and ranges from dimers to antiferromagnetic order. To clarify the electronic structure, we perform calculations based on density functional theory. We present systematic investigations of the local density of states at the chain copper sites and the band structure. The hybridization between the chains, ladders and electron donor ions is found to be negligible. The band structure of coupled corner-shared CuO chains resembles the band structure of the composite system. The chains are well described in terms of two characteristic electronic bands at the Fermi energy.

TT 14.18 Tue 19:00 H19

Interplay of structure and electronic properties in metalorganic spin chain and spin crossover compounds — •Harald O. Jeschke[1], Martin U. Schmidt[2], Tanusri Saha-Dasgupta[3], and Roser Valenti[1] — [1]Institut für Theoretische Physik, Universität Frankfurt, Germany — [2]Institut für Anorganische und Analytische Chemie, Universität Frankfurt, Germany — [3]S.N.Bose National Centre for Basic Sciences, Kolkata, India

We employ a combination of first principles methods to study the electronic and magnetic properties of metalorganic coordination complexes. By combining force field methods and *ab initio* molecular dynamics we construct model structures which are suitable for analysis with precise density functional theory methods. We employ NMTO downfolding to study the relative importance of the interaction paths between the metal centers. In a Cu^{2+} complex that forms a Heisenberg spin 1/2 chain we investigate the possibility of tuning the band width and dimensionality by simple substitutions. In a model Fe^{2+} triazole polymer we investigate the mechanism for the high spin-low spin transition.

TT 15: Superconductivity - Tunneling, Josephson Junctions, SQUIDs

Time: Tuesday 14:00–17:15 Location: H20

TT 15.1 Tue 14:00 H20

Untersuchung von planaren HTSL Flip-Chip dc-SQUID Gradiometern — •Christoph Becker[1], Alexander Steppke[1], Veit Grosse[1], Hendrik Schneidewind[2], Lutz Redlich[2], Frank Schmidl[1] und Paul Seidel[1] — [1]Institut für Festkörperphysik, Friedrich- Schiller-Universität Jena, Germany — [2]Institut für Physikalische Hochtechnologie e.V., Jena, Germany

Die Feldgradientenauflösung von planaren hochtemperatursupraleitenden (HTSL) dc-SQUID Gradiometern kann mittels supraleitenden Flußtransformern gesteigert werden. Die Gradiometer wurden dabei hinsichtlich der Fehlerrate optimiert. Die Gradiometer sind mit unserem Standard U-Form dc-SQUID-Layout versehen, das photolithografisch aus den 150 nm dünnen YBCO Schichten auf 10x10 mm^2 $SrTiO_3$ Bikristallsubstraten strukturiert wird. Die Schichtherstellung erfolgt mittels PLD. Als supraleitende Flußtransformer werden einerseits YBCO Antennen auf vorgeformten $SrTiO_3$ Substraten verwendet. Andererseits kommen Flußtransformer aus 200 nm dünnen TBCCO Schichten auf 2"$LaAlO_3$ oder Saphir-Substraten zum Einsatz. Diese werden nach der Schichtherstellung strukturiert und geschnitten.

Vorgestellt werden die elektrischen Eigenschaften der verschiedenen Flip-Chip Konfigurationen, wie I_CR_N-Produkt, Spannungshub, die effektive Fläche der Sensoren und deren Balance. Die Ergebnisse zur Langzeitstabilität der SiO_2 Passivierung und das Verhalten der Sensoren in magnetisch geschirmter und ungeschirmter Umgebung werden gezeigt. Spezielles Augenmerk wird dabei auf die Rauscheigenschaften in magnetisch ungeschirmter Umgebung gelegt.

TT 15.2 Tue 14:15 H20

Coupling mechanism of a mm wave radiation to Josephson junctions in an open resonator — •A. M. Klushin, M. He, M. Kurochka, and N. Klein — Institute of Bio- and Nanosystems and CNI-Centre of Nanoelectronic Systems for Information Technology Forschungszentrum Jülich GmbH, D-52425 Jülich, Germany

We have explored the coupling mechanism of a millimeter wave radiation to bicrystal Josephson junction arrays embedded in a hemispherical Fabry-Perot resonator [1]. We have found that our high-temperature superconductor array can be modeled as a thin film grid polarizer. In agreement with this model, a strong dependence of the coupling of the Josephson junctions on the polarization of the electric filed in the resonator was observed. We achieved a maximum Josephson voltage about 30 mV for an array of 182 bicrystal junctions at a temperature of 75K and a frequency of 75 GHz. Our results showed that such circuits are challenging for application in a quantum voltage metrology. It is important to note that our quasioptical coupling method can be extended up to terahertz frequencies. Here, our approach appears very promising for the realization of THz sources and detector arrays. Finally, our approach could be useful for irradiation of large arrays of niobium Josephson junctions as well. In this case, a substantial simplification of the technology of niobium arrays, and an increase of the irradiation frequency could be achievable.

[1] Appl. Phys. Lett. 89, 232505 (2006)

TT 15.3 Tue 14:30 H20

Unusual Properties of High–T_c SQUIDs — •Christof Schneider[1], Florian Loder[1], Thilo Kopp[1], John Kirtley[2], Helene Raffy[3], and Jochen Mannhart[1] — [1]Lehrstuhl für Experimentalphysik VI, Institut für Physik, Universität Augsburg, D-86135 Augsburg — [2]IBM Thomas J. Watson Research Center, P.O.Box 218, Yorktown Heights, New York 10598, USA — [3]Laboratoire de Physique des Solides, Université de Paris-Sud, 91405 Orsay, France

Current-voltage characteristics of SQUIDs show a periodic variation of the critical current as a function of the applied magnetic field.

Usually, the periodicity corresponds to one flux quantum $\Phi_0 = h/2e$. Low-inductance high–T_c grain boundary SQUIDs with a 0°/45° misorientation however, display systematically a characteristic periodicity of the critical current of $1/2 \times \Phi_0$ in small magnetic fields. In this contribution we present a systematic study of high–T_c SQUIDs with different grain boundary misorientation angles. For most misorientations, critical current oscillations with periods of $1/2 \times \Phi_0$ in small magnetic fields have been identified. SQUIDs prepared on 24° and 30° bicrystalline substrates show highly unusual and complex diffraction patterns. The interpretation of the phase–sensitive experiments is only partly consistent with higher harmonics of the current–phase relation for the Josephson current.

TT 15.4 Tue 14:45 H20

Coupling of external electromagnetic fields to supercurrents: From SQUID to SQIF — •Nils Schopohl — Eberhard-Karls-Universitaet Tuebingen, Institut fuer Theoretische Physik, Lehrstuhl Theoretische Festkoerperphysik, Auf der Morgenstelle 14, D-72076 Tuebingen

Basic principles of Josephson junction based interferometers are reviewed. Key features of parallel and also serial Superconducting Quantum Interference Filters (SQIFs) are explained in detail. Results of recent mixing experiments with radiofrequency signals between 100 MHZ and 20GHz are discussed and analyzed with help of a simple model.

TT 15.5 Tue 15:00 H20

Josephson tunnel junctions with ferromagnetic barrier layer — •Martin Weides[1], Hermann Kohlstedt[1], Matthias Kemmler[2], Dieter Koelle[2], Reinhold Kleiner[2], and Edward Goldobin[2] — [1]Institute for Solid State Research, Research Centre Jülich — [2]Physikalisches Institut - Experimentalphysik II,

We have fabricated $Nb/Al_2O_3/Ni_{0.6}Cu_{0.4}/Nb$ Josephson tunnel junctions[1]. Depending on the thickness of the ferromagnetic $Ni_{0.6}Cu_{0.4}$ layer and on the ambient temperature, the junctions were in the 0 or π coupled ground state[2]. The Al_2O_3 tunnel barrier allows to achieve rather low damping. The critical current density in the π state was up to 5 A/cm^2 at $T = 2.1$ K, resulting in a Josephson penetration depth λ_J as low as 160 μm. Experimentally determined junction parameters are well described by theory taking into account spin-flip scattering in the $Ni_{0.6}Cu_{0.4}$ layer and different interface transparencies. Using a ferromagnetic layer with a step-like thickness we obtain a 0–π junction with equal lengths and critical currents of 0 and π parts. The $I_c(H)$ pattern shows a clear minimum in the vicinity of zero field. The ground state of our 330 μm (1.3 λ_J) long junction corresponds to a spontaneous vortex of supercurrent pinned at the 0–π phase boundary, carrying $\sim 6.7\%$ of the magnetic flux quantum Φ_0[3].

[1] Weides *et al.*, Physica C **437-438**, 349 (2006)
[2] Weides *et al.*, Appl. Phys. Lett. **89**, 122511 (2006)
[3] Weides *et al.*, Phys. Rev. Lett. (12/2006)

15 min. break

Invited Talk TT 15.6 Tue 15:30 H20

Fractional flux quanta in Josephson junctions — •Edward Goldobin[1], Kai Buckenmaier[1], Tobias Gaber[1], Matthias Kemmler[1], Martin Weides[2], Judith Pfeiffer[1], Hermann Kohlstedt[2], Dieter Koelle[1], Reinhold Kleiner[1], and Michael Siegel[3] — [1]Physikalisches Institut – Experimentalphysik II, Universität Tübingen, Auf der Morgenstelle 14, D-72076 Tübingen, Germany — [2]Center of Nanoelectronic Systems for Information Technology (CNI), Research Centre Jülich, D-52425 Jülich, Germany — [3]Institut für Mikro– und Nanoelektronische Systeme, Universität Karlsruhe, Hertzstr. 16, D-76187 Karlsruhe, Germany

Fractional Josephson vortices may appear in the so-called 0-κ Josephson junctions (κ is an arbitrary number) and carry magnetic flux Φ, which is a fraction of the magnetic flux quantum $\Phi_0 \approx 2.07 \times 10^{-15}$ Wb. Their properties are very different from the usual integer fluxons: they are pinned, and often represent the ground state of the system with spontaneous circulating supercurrent. They behave as well controlled macroscopic spins and can be used to construct bits, qubits, tunable photonic crystals and to study the (quantum) physics of spin systems.

In this talk we discuss recent advances in 0-π junction technology and present recent experimental results: evidence of the spontaneous flux in the ground state[1], spectroscopy of the fractional vortex eigenfrequencies[2] and observation of dynamics effects related to the flipping of the fractional vortices.

[1] M. Weides et al., Phys. Rev. Lett. **97**, 247001 (2006).
[2] K. Buckenmaier et al., cond-mat/0610043.

Invited Talk TT 15.7 Tue 16:00 H20

SQUID Technology for Geophysical Exploration — •Hans-Georg Meyer, Ronny Stolz, Andreas Chwala, Sven Linzen, and Volkmar Schultze — Institute for Physical High Technology, Albert-Einstein-Straße 9, D-07745 Jena, Germany

Magnetic measurements are widely used for geophysical exploration. The fields of applications are ranging from mineral exploration, environmental and military monitoring to archaeometry. During the past few years several SQUID systems for geomagnetic measurements have been developed and successfully tested. Compared to conventional systems their outstanding performance was demonstrated. The latest of such systems are mainly based on LTS SQUIDs and shall be summarized here.

Airborne geophysics is extremely interesting in prospecting, since they allow effectively covering large areas with sufficiently high spatial resolution in a short period of time. Geomagnetics detects basically anomalies of the Earth's magnetic field. In order to use sensitive SQUID gradiometers in airborne applications a high common mode rejection is necessary, since the parasitic areas of the SQUID gradiometer lead to motion noise if the gradiometer is tilted in the Earth's magnetic field. The recently developed planar LTS SQUID gradiometers with a base length of 3.5 cm show an intrinsic balance of about 10^4. In this way a noise limited gradient field resolution better than 100 fT/[m*sqrt(Hz)] down to 0.1 Hz is achieved. By means of the airborne SQUID system the complete gradient tensor of the Earth's magnetic field was measured with superior accuracy never reached so far.

TT 15.8 Tue 16:30 H20

A LTS-SQUID System for Geomagnetic Prospection — •Sven Linzen[1], Ronny Stolz[1], Volkmar Schultze[1], Andreas Chwala[1], Marco Schulz[1], Tim Schüler[2], Nikolai Bondarenko[1], Sebastian Hauspurg[1], and Hans-Georg Meyer[1] — [1]Institute for Physical High Technology, A.-Einstein-Str. 9, D-07745 Jena — [2]Thuringian State Office for Archaeology, Humboldtstr. 11, D-99423 Weimar, Germany

The geomagnetic mapping of large areas gains in importance in archaeology. High sensitive sensors are necessary to resolve the small magnetic signals of buried structures like adobe walls, tombs or magnetic traces of ancient wood palisades which are completely decomposed nowadays. The sensitivity and bandwidth of state-of-the-art caesium magnetometer systems, however, are not sufficient in many cases. Thus, we built a niobium SQUID based system to overcome these limitations. Our highly balanced planar gradiometers as well as the SQUID electronics and data acquisition are carried by a non-metallic cart which allows a soft and fast motion over ground. An inertial system as well as differential GPS completes the setup which provides us the local position of our gradiometers with a resolution of 10 cm. Fast mapping with about one hectare per hour can be performed with the system pulled by a cross-country car. We present experimental data which were acquired during several field campaigns in Europe and South America. Furthermore, we discuss the application of our system in foundation soil analysis.

This work was supported by the German BMBF, the Free State of Thuringia, and the European Union.

TT 15.9 Tue 16:45 H20

Compact noise thermometer for mK-temperatures based on integrated SQUID magnetometers — •Alexander Kirste[1], Jörn Beyer[1], Dietmar Drung[1], Jost Engert[1], Margret Peters[1], Cornelia Assmann[1], Thomas Schurig[1], Astrid Netsch[2], Andreas Fleischmann[2], and Christian Enss[2] — [1]Physikalisch-Technische Bundesanstalt, AG Kryosensoren, Abbestraße 2-12, 10587 Berlin, Germany — [2]Kirchhoff-Institut für Physik, Universität Heidelberg, Im Neuenheimer Feld 227, D-69120 Heidelberg, Germany

We report on the development and optimization of very compact noise thermometers for the temperature range of the PLTS-2000. They are based on the detection of the magnetic field fluctuations above the surface of a metal body by means of thin film SQUID magnetometers. The thermally driven Johnson noise currents inside a metal body produce fluctuating magnetic fields, which can be detected by highly sensitive low-Tc dc-SQUID magnetometers or gradiometers placed close to the metal surface. The fundamental fluctuation-dissipation theorem provides a direct relation between temperature and noise currents or field fluctuations to be measured: The power spectral density of the thermal

magnetic flux density noise is strictly proportional to the temperature, provided the electrical conductivity does not change. Thus, the temperature of the metal body can be determined from the spectrum of the magnetic flux detected by the SQUID, making up a semi-primary thermometer. Since the spectrum of these fluctuations depends significantly on the configuration of pick-up coil and metal body, it must be optimized to achieve the largest noise signal (power) for a limited chip area. This has been done resulting in thin film miniature multiloop SQUID gradiometers. We present measurements of the integrated magnetic field fluctuation thermometer characterizing its sensitivity and speed.

TT 15.10 Tue 17:00 H20

Macroscopic Quantum Tunneling of $Bi_2Sr_2CaCu_2O_{8+\delta}$ Intrinsic Josephson Junction SQUIDs — •X. Y. Jin, J. Lisenfeld, Y. Koval, A. V. Ustinov, and P. Müller — Physikalisches Institut III, Universität Erlangen-Nürnberg

The properties of $Bi_2Sr_2CaCu_2O_{8+\delta}$ superconducting rings broken by intrinsic Josephson junction stacks were studied. The stack height was between 4 and 50 junctions. SQUID behavior was observed in all devices. The modulation depth of the critical currents increased with decreasing number of junctions in the stack, and conformed to the β_L values. Crossover temperatures between the thermal and the quantum regime were in the range of 300 to 600 mK. Whereas the small stacks behaved like series arrays of independent junctions, the larger stacks were uniform and showed anomalous enhancement of escape rates. An unconventional correlated retrapping was observed, i.e., the retrapping probability decayed exponentially with the trapped flux. This phenomenon indicates that the intrinsic SQUID is a strongly driven Tera-Hertz harmonic oscillator in phase space, where intrinsic Josephson junction stacks can provide both very high inductance and very high charging energy simultaneously. Possible implications for the realization of high-T_c phase qubits are discussed.

TT 16: Symposium "50 Years BCS Theory"

Time: Tuesday 18:00–20:00 Location: H20

TT 16.1 Tue 18:00 H20

BCS theory of a neutral Fermi liquid: the superfluid phases of Helium 3 — •Peter Woelfle — Institut f. Theorie der Kondensierten Materie, Universitaet Karlsruhe, 76128 Karlsruhe

The superfluid phases of Helium 3 are described in the framework of BCS theory with Cooper pairs of angular momentum L=1 and spin S=1. The necessary attractive interaction is mediated by intrinsic fluctuations of spin and mass current. The internal structure of the Cooper pairs allows for the existence of several different phases featuring a broad spectrum of excitations (nuclear spin resonance, zero sound, pair vibrations, vortices). Of particular interest is the existence of textures of the order parameter preferred directions, providing a background for unusual fermionic excitations. Analogies in the behavior of the superfluid A-phase with problems of current interest in elementary particle physics (chiral anomaly) and cosmology (Kibble-Zurek mechanism) may offer new insights to be gained from Helium laboratory experiments.

TT 16.2 Tue 18:30 H20

Unconventional BCS States in Heavy-Fermion Superconductors — •Frank Steglich — Max Planck Institute for Chemical Physics of Solids, Dresden, Germany

Heavy-fermion (HF) superconductivity (SC) discovered in 1979 often occurs in the vicinity of an antiferromagnetic (AF) quantum critical point (QCP). Here, we concentrate on the prototypical HF compound $CeCu_2Si_2$, whose phase diagram also contains 'phase A', an ordinary spin density wave (SDW) with very small ordered moment. Application of low pressure was found to smoothly suppress 'phase A' and to establish an antiferromagnetic (AF) QCP of (3D) SDW type. A narrow superconducting dome centered around this QCP exists in the T-p phase diagram of $CeCu_2Si_{1.8}Ge_{0.2}$ - similar to what was discovered earlier for $CePd_2Si_2$ [Mathur et al. (1998)]. Different from its Pd homologue, however, $CeCu_2Si_{1.8}Ge_{0.2}$ exhibits a second superconducting dome, coinciding with a weak valence transition near $p = 5$ GPa. Because of the low-lying critical end point of the first-order valence transition line, SC under this high-p dome is likely to be mediated by charge-density fluctuations [Miyake et al. (1999)]. Here, we discuss experimental evidence for HFSC in $CeCu_2Si_2$ under the low-p dome to be due to AF quantum critical paramagnons, as first proposed in the case of $CePd_2Si_2$. The lack of SC in the isostructural quantum critical material $YbRh_2Si_2$ will also be addressed.
Work done in collaboration with: P. Gegenwart, C. Geibel, F.M. Grosche, S. Jeevan, M. Loewenhaupt, O. Stockert, S. Wirth and H. Q. Yuan.

TT 16.3 Tue 19:00 H20

Hochtemperatur-Supraleitung: Ein Beispiel für die BCS-Idee? — •Werner Hanke — Institut für Theoretische Physik & Astrophysik, Universität Würzburg

Der Vortrag gibt einen Überblick über den aktuellen Stand der mikroskopischen Theorie der Paarbildung und Supraleitung in den Hoch-Tc Materialien(HTSL). Ausgehend von grundlegenden Experimenten wird die Frage diskutiert, inwieweit die BCS-Idee in diese Theorie eingeht, bzw. diese Idee, auf Grund zum Beispiel der starken Korrelationen der Ladungsträger und der damit verbundenen eventuellen Aufhebung des Quasiteilchen-Bildes, entscheidende Korrekturen erfährt.

TT 16.4 Tue 19:30 H20

Strolling through and beyond the Fields of BCS — •Jochen Mannhart — Universität Augsburg, EKM, Institut für Physik

The BCS-model has proved to be a powerful approach for describing key aspects of low- and high-temperature superconductivity as well as of superfluidity. The theory is brilliant in its success and has been understood in fantastic detail.

Emphasizing the power of BCS, we shall show that the BCS-theory predicts the electron systems of the high-temperature superconductors to display extraordinary and surprising collective phenomena which are as yet unknown in superconductivity.

We will also discuss current and possibly future trends in superconductivity which push the physics far beyond the BCS-limits and open vast, new ranges.

The work to be presented was performed together with Y.S. Barash, G. Hammerl, F. Loder, A. Kampf, T. Kopp, and C.W. Schneider.

TT 17: Heavy Fermions

Time: Wednesday 14:00–18:00 Location: H18

TT 17.1 Wed 14:00 H18

Antiferromagnetic groundstate in $CeCu_2(Si_{0.55}Ge_{0.45})_2$ with broken body center — •Enrico Faulhaber[1], Oliver Stockert[2], Astrid Schneidewind[1,3], Micha Deppe[2], Christoph Geibel[2], Frank Steglich[2], and Michael Loewenhaupt[1] — [1]TU Dresden; Institut für Festkörperphysik; Zellescher Weg 16; D-01062 Dresden — [2]Max-Planck-Institut CPfS; Nöthnitzer Str. 40; D-01187 Dresden — [3]Forschungsneutronenquelle Heinz Meier-Leibnitz; D-85747 Garching

The heavy fermion system $CeCu_2(Si_{1-x}Ge_x)_2$ allows to study the interplay between antiferromagnetism and superconductivity (for $x \leq 0.1$). $CeCu_2(Si_{0.55}Ge_{0.45})_2$ is especially interesting, since its characteristic temperatures which are easier accessible than in $CeCu_2Si_2$, and the value of the ordered magnetic moment ($\mu_{Ce} \approx 0.5\ \mu_B$) [1] qualify it as a reference system for the magnetic structures within the system.

Recently, we performed an elastic neutron scattering experiment on the PANDA triple-axis-spectrometer at the FRM-II, tuned for high q resolution. Additional satellite peaks were observed below $T_L \approx 1.4 \pm 0.1$ K $< T_N \approx 3.1$ K consistent with the same incommensurate propagation vector $\tau = (0.27\ 0.27\ 0.51)$ found above T_L, but corresponding to a broken symmetry of the body centred $ThCr_2Si_2$ structure ($I4/mmm$) and, therefore, a reduced Brillouin zone. Our findings can be modelled with two magnetic sublattices formed by counterrotating cycloids. The results will be discussed in comparison to previous measurements.

[1] E. Faulhaber et al., J. Magn. Magn. Mater. **272** (2004) 44.

TT 17.2 Wed 14:15 H18

Pressure depending μSR measurements on $CeCu_2Si_2$ — •Astrid Schneidewind[1], Oliver Stockert[2], Daniel Andreica[3], Alex Amato[3], Julia Arndt[2], Hirale S. Jeevan[2], Christoph Geibel[2], and Frank Steglich[2] — [1]Institut für Festkörperphysik, TU Dresden, D-01062 Dresden, Germany — [2]MPI-CPfS, Nöthnitzer Str. 40, D-01178 Dresden, Germany — [3]Laboratory for Muon-Spin Spectroscopy, CH-5232 Villigen PSI, Switzerland

The heavy-fermion compound $CeCu_2Si_2$ is located quite close to a quantum phase transition (QPT) at the disappearence of magnetic order. Applying pressure the QTP can be tuned without any change of the amount of disorder. We performed weak transverse-field μSR measurements to investigate an A/S-type $CeCu_2Si_2$ single crystal and to study how the antiferromagnetic order vanishes under pressure and gives way to superconductivity. With increasing pressure the Néel temperature decreases until the magnetic signal finally vanished. In the superconducting state the magnetic volume decreases with lowering temperature while superconducting volume increases as expected from ambient pressure measurements [1]. This can be related to phase separation into magnetically ordered and superconducting regions. Surprisingly, the temperature range, where magnetism and superconductivity are co-existing, becomes narrower with increasing pressure. In conclusion, applying pressure leads to a stabilization of superconductivity and supression of antiferromagnetism in $CeCu_2Si_2$.

[1] Stockert et al., Physica **B374-375 (2006) 415.**

TT 17.3 Wed 14:30 H18

Polarization dependent Ce-M_{45} x-ray spectroscopy on $CeCu_2Si_2$ and $CePd_2Si_2$: a new approach to determine the symmetry of the lowest crystal field states — •P. Hansmann[1], A. Severing[1], Z. Hu[1], C.F. Chang[1], S. Klein[1], H.J. Lin[2], C.T. Chen[2], B. Fak[3], C. Geibel[4], F. Steglich[4], and L.H. Tjeng[1] — [1]II. Phys. Inst., Univ. Köln, Cologne — [2]NSRRC Hsinchu, Taiwan — [3]CEA, SPSMS, Grenoble, France — [4]MPI CPFS, Dresden

In the past neutron scattering as the standard technique has given confusing and often contrary results about the symmetry of the lowest crystal field states of correlated RE compounds, particularly on $CeCu_2Si_2$ [1,2] and $CePd_2Si_2$ [3,4,5]. The knowledge about these lowest states is crucial for the understanding of the magnetic properties and also provides an important ansatz for a proper description of the low energy electronic structure including the Fermi surface. We will present results obtained with a different technique, namely soft-x-ray absorption spectroscopy (XAS) at the Ce-M_{45} edges. This technique is known to be sensitive to the symmetry of the initial state and through the polarization dependence we obtain direct spectroscopic information about the $|J_z\rangle$ admixtures of the ground state. XAS used in this manner should be a powerful new tool, complementary to neutrons, in determining the symmetry of crystal field ground states in RE.

[1] S. Horn et al. PRB 23 (1981) 3171 [2] E.A. Gorimychkin et al. PRB 47 (1993) 14280 [3] A. Severing et al. PRB 39 (1989) 2557 [4] R.A. Steemann et al. J. Appl. Phys. 67 (1990) 5203 [5] N.H. van Dijk et al. PRB 61 (2000) 8922

TT 17.4 Wed 14:45 H18

Study of a smeared ferromagnetic quantum phase transition in $CePd_{1-x}Rh_x$ single crystals — •Micha Deppe[1], Tanja Westerkamp[1], Adam Pikul[1], Nubia Caroca-Canales[1], Christoph Geibel[1], Robert Küchler[1], Philipp Gegenwart[1], and Julian Sereni[2] — [1]Max-Planck-Institute for Chemical Physics of Solids, 01187 Dresden, Germany — [2]Lab. Bajas Temperaturas, Centro Atómico Bariloche (CNEA), 8400 S.C. de Bariloche, Argentina

Appropriate Cerium based compounds for the study of a ferromagnetic (quantum) critical point are extremely scarce. On the other hand the orthorhombic alloy $CePd_{1-x}Rh_x$ shows a continuous decrease of the ferromagnetic transition temperature $T_C(x)$ from 6.6 K for $x =$ 0 to 0.025 K at $x = 0.87$. Detailed low temperature measurements of $CePd_{1-x}Rh_x$ polycrystalline samples showed an extended range of non-Fermi liquid behavior between $0.85 \leq x \leq 0.9$, suggesting a smeared ferromagnetic quantum phase transition near $x_{cr} \approx 0.87$. We extended our studies on $CePd_{1-x}Rh_x$ single crystals, which allow to include anisotropy effects in the study and analysis of this system. The anisotrophy is quite strong for $x \leq 0.6$ with the easy axis along the c-direction, but decreases rapidly for $x \geq 0.7$. Furthermore the ferromagnetic signal in the ac-susceptibility becomes frequency dependent at $x \geq 0.72$ supporting a suppression of long-range magnetic order. We explain the unusual magnetic behavior of $CePd_{1-x}Rh_x$ with a distribution of local Kondo temperatures near x_{cr} due to disorder introduced by Pd → Rh exchange and the formation of a "Kondo - Cluster glass".

TT 17.5 Wed 15:00 H18

Larmor diffraction study of the thermal expansion of URu_2Si_2 under high pressure — •Philipp Niklowitz[1], Christian Pfleiderer[1], Thomas Keller[2,3], and John Mydosh[4] — [1]Physik Department E21, Technische Universität München, 85748 Garching, Germany — [2]Max-Planck-Institut für Festkörperforschung, 70569 Stuttgart, Germany — [3]ZWE FRMII, Technische Universität München, 85748 Garching, Germany — [4]II. Physikalisches Institut, Universität zu Köln, 50937 Köln, Germany

The metallic rare-earth system URu_2Si_2 shows two transitions at zero pressure: at $T_0 \approx 17.5$ K a strong peak in the heat capacity indicates the transition to an unknown so-called hidden order (HO) state; the HO state might be relevant to explain the occurance of a superconducting state at $T_s \approx 1.4$ K. A key to the HO state might be the large-moment AF state, to which the HO state is transformed under pressure. The pressure dependence of T_0 is surprisingly weak across the pressure induced phase change and it is interesting to follow the pressure evolution of thermodynamic quantities.

We have studied the pressure evolution of the thermal expansion from zero pressure to 20 kbar and in a wide temperature range down to 3 K. Larmor diffraction experiments have been performed on a high quality single crystal of stoichiometric URu_2Si_2. In particular, we present in detail the pressure evolution of the signature of T_0 in the thermal expansion of the a- and c-axis. Here, Larmor diffraction proves to be a very reliable technique for high precision measurements of the lattice constants.

TT 17.6 Wed 15:15 H18

Pressure-temperature phase diagram of URu_2Si_2 by resistivity measurements — •Elena Hassinger[1,2], Georg Knebel[2], Bernard Salce[2], Jacques Flouquet[2], and Pascal Lejay[3] — [1]KIP, Universität Heidelberg, Germany — [2]DRFMC, SPSMS, CEA Grenoble, France — [3]CRTBT, CNRS Grenoble, France

At ambient pressure URu_2Si_2 undergoes a transition at $T_0 = 17.5$ K to so called hidden order phase and a second transition to superconducting ground state at $T_{SC} = 1.5$ K. We measured the resistivity of a small single crystal in highly hydrostatic pressure up to 2.5 GPa in a diamond anvil pressure cell with Argon as pressure transmitting medium. At the critical pressure $p_c = 0.5\ GPa$ a large moment antiferromagnetic phase develops and can be seen as a small anomaly in the resistivity curves ρ(T) at constant pressure. In these measurements the superconducting transition can be seen up to 1.3 GPa. In the vicinity of p_c the resistivity curves in the normal state at low temperature follow a power law with an exponent smaller than 2 indicating non Fermi liquid behavior.

TT 17.7 Wed 15:30 H18

Study of energy scales in $Lu_{1-x}Yb_xRh_2Si_2$ — •Ulrike Köhler[1], Samuel Maquilon[2], Cornelius Krellner[1], Niels Oeschler[1], Christoph Geibel[1], Veljko Zlatić[3], Zachary Fisk[4], and Frank Steglich[1] — [1]MPI for Chemical Physics of Solids, Dresden, Germany — [2]University of California, Davis, USA — [3]Institute of Physics, Zagreb, Croatia — [4]University of California, Irvine, USA

In strongly correlated f-electron systems, Kondo interaction and crystal electric field (CEF) excitations often give rise to large anomalies in the thermopower. Thermopower investigations are therefore known to be a useful tool to determine the Kondo and CEF energy scales.

Measurements of the thermopower of the stoichiometric heavy fermion system $YbRh_2Si_2$ revealed a single large minimum around 80 K which was attributed to both, Kondo interaction and CEF effects. From the obtained data no separation of Kondo and CEF energy scales was possible. We performed thermopower measurements on the

diluted heavy fermion system $Lu_{1-x}Yb_xRh_2Si_2$. For Yb concentrations of $x \leq 0.5$ the pronounced thermopower minimum splits into 2 separate features. An extrapolation of the position of the low temperature shoulder allows to determine the Kondo temperature of pure $YbRh_2Si_2$ ($T_K \approx 25$ K). Our data suggest a strong dependence of the minima on the Yb concentration x that may not be solely attributed to the extremely small unit cell volume change. We compare our results to theoretical calculations of the high temperature thermopower of Yb intermetallics including both, CEF splitting and charge fluctuations.

TT 17.8 Wed 15:45 H18

Pressure dependence of the characteristic Kondo temperature of $YbRh_2Si_2$ — •Gabriel Alejandro Dionicio, Heribert Wilhelm, Julia Ferstl, Christoph Geibel, and Frank Steglich — Max-Planck-Institute for Chemical Physics of Solids

Several anomalies were observed in the electrical resistivity of $YbRh_2Si_2$ as a funtion of the pressure,namely, T_N and maxima at T_{max} and T_{max}^{low}. The engative logarithmic temperature dependence of the electrical resistivity $\rho(T)$ for $T > T_{max}$ and for $T > T_{max}^{low}$ indicates that a combined incoherent Kondo scattering on the ground state and the excited CEF-levels are responsible for these anomalies. Therefore, we attempt to infer the pressure dependence of the characteristic Kondo temperature $T_K(p)$ of $YbRh_2Si_2$ by means of a simple model that considers the effect of the orbital degeneracy on a dense Kondo state and the compressible Kondo lattice model. $T_K(p)$ is compared with the pressure dependence of the Néel temperature $T_N(p)$, in particular in the pressure range 4 GPa $< p <$ 9 GPa where $T_N(p)$ shows a quasi-pressure independent behavior.

15 min. break

TT 17.9 Wed 16:15 H18

Ferromagnetism in the layered Kondo system CeRuPO — •Cornelius Krellner[1], Nagesh Kini[2], Eva Maria Bruening[1], Michael Nicklas[1], Michael Baenitz[1], and Christoph Geibel[1] — [1]Max Planck Institute for Chemical Physics of Solids, Nöthnitzer Str. 40, 01187 Dresden, Germany — [2]Department of Applied Chemistry, Hiroshima University, Higashis-Hiroshima 739-8527, Japan

Intermetallic Kondo lattice systems have attracted considerable attention in the last decades. While there exist many Ce-based compounds showing antiferromagnetic ground states, only very few systems are known which exhibit ferromagnetic order. On the way to find new Ce-based Kondo lattices close to a ferromagnetic quantum phase transition, the CeTPO (T=transition metal) compound series attracted our interest, because of the rather unusual crystal structure with alternating layers of TP_4 and OCe_4 tetrahedra. In this contribution, we will present the first investigations of the physical properties of CeRuPO crystallizing with the tetragonal ZrCuSiAs type structure (P4/nmm). Measurements of the magnetic susceptibility reveal that Cerium is in a trivalent state with a ferromagnetic transition at $T_C = 15$ K which is confirmed in the temperature dependence of specific heat. A pronounced decrease of the resistivity below 50 K and enhanced thermopower $S(10\text{ K}) = 10\ \mu$V/K confirm the presence of Kondo interaction. Detailed study of ^{31}P NMR and results of the magnetization under pressure up to 2 GPa will be discussed. In addition, we show first investigations of the physical ground states of the isostructural compounds CeTPO (T = Os, Fe, Co).

TT 17.10 Wed 16:30 H18

Pressure Dependence of The Néel in $CeRhIn_{5-x}Sn_x$ Studiedby Thermal Expansion — •J. Guido Donath[1], Philipp Gegenwart[1,3], Eric D. Bauer[2], John L. Sarrao[2], and Frank Steglich[1] — [1]Max-Planck-Institute for Chemical Physics of Solids, 01187 Dresden, Germany — [2]Los Alamos National Laboratory, Los Alamos, New Mexico, 87545 USA — [3]I. Physikalisches Institut, Universitaet Goettingen, Friedrich-Hund-Platz 1, 37077 Goettingen, Germany

We present low-temperature thermal expansion measurements on the Sn-substituted heavy fermion antiferromagnet $CeRhIn_{5-x}Sn_x$ for $0 \leq x \leq 0.48$ in which $T_N(x)$ is linearly suppressed from 3.8 K at $x = 0$ to zero at $x_c \approx 0.4$. The application of the Ehrenfest relation allows to calculate the initial uniaxial and hydrostatic pressure dependences $\mathrm{d}T_N/\mathrm{d}P$ at various x. The observed non-linear variation with x is interpreted in terms of the Doniach diagram by an increase of the $4f$-conduction electron hybridization induced by Sn-doping. As no traces of superconductivity are observed close to x_c, this system is ideally suited for the study of the magnetic quantum critical point.

TT 17.11 Wed 16:45 H18

Thin-film growth of the heavy-fermion superconductor $CeCoIn_5$ — •Oleksiy Soroka and Michael Huth — Physicalisches Institut, J. W. Goete–Universität, Max-von-Laue-Str. 1, D-60438

Thin films of $CeCoIn_5$ were deposited on different substrates by using molecular beam epitaxy and found superconductive with transition temperatures about 2 K. Their transport properties are comparable with those of the bulk material and the resistivity shows typical heavy fermion behaviour. The growth characteristics were studied by means of x-ray diffraction and scanning tunneling microscopy and revealed (001)-oriented growth with pronounced island formation. Based on the chemical composition of the films obtained using energy dispersive x-ray analysis a ternary phase formation diagram was deduced. The heavy fermion compound $CeCoIn_5$ is a member of a recently discovered layered heavy fermion family with general formula $CeMIn_5$ (M=Co, Ir, Rh). These compounds exhibit many ground states that have been observed in f-electron systems, including paramagnetism, antiferromagnetism, exotic ambient-pressure and pressure induced superconductivity. There exists a relationship to the high-T_c superconductors as well. The layered quasi-2D crystal structure of these materials and that of the high-T_c cuprates share common features with regard to their spin-dependent electronic excitation spectrum. The most direct technique to investigate the spectrum of these excitations is tunneling spectroscopy which benefits strongly from well-defined surface as presented by epitaxial thin films.

TT 17.12 Wed 17:00 H18

Paramagnetic moment in RFe_2Ge_2 (R = Lu and Yb) — •Julia Ferstl, Helge Rosner, and Christoph Geibel — Max Planck Institut für Chemische Physik fester Stoffe

We synthesised polycrystals and then grew single crystals of $YbFe_2Ge_2$ and $LuFe_2Ge_2$. The analysis of their physical properties revealed the presence of a paramagnetic Fe-moment of 3 μ_B/Fe at high temperatures in both compounds, which strongly contrasts the well established non-magnetic behavior of Co and Fe in the RCo_2Si_2, RCo_2Ge_2 and RFe_2Si_2 compound series. Additionally a phase transition at $T_0 \approx 9$ K appears in $LuFe_2Ge_2$, which likely corresponds to antiferromagnetic ordering of the Fe-moments. The observation of a paramagnetic Fe-moment is discussed in the context of results from LDA-calculations. Our results in $YbFe_2Ge_2$ further indicate an intermediate valent Yb state with a comparatively low characteristic $4f$ energy of 80 K. This corresponds to a valence close to but less then 3. At low temperatures we observe a heavy Fermion behaviour with a moderately enhanced Sommerfeld coefficient $\gamma = 200$ mJ·mol^{-1}K^{-2}.

TT 17.13 Wed 17:15 H18

Theory of magnetic excitons in the heavy-fermion superconductor UPd_2Al_3 — •Jun Chang[1], Ilya Eremin[1,2], Peter Thalmeier[3], and Peter Fulde[1] — [1]Max-Planck Institut für Physik komplexer Systeme, D-01187 Dresden, Germany — [2]Institute für Mathematische und Theoretische Physik, Technische Universität Carolo-Wilhelmina zu Braunschweig, 38106 Braunschweig, Germany — [3]Max-Planck Institut für Chemische Physik fester Stoffe, D-01187 Dresden, Germany

We analyze the influence of unconventional superconductivity on the magnetic excitations in the heavy fermion compound UPd_2Al_3. We show that it leads to the formation of a bound state at energies well below $2\Delta_0$ at the antiferromagnetic wave vector $\mathbf{Q}=(0,0,\pi/c)$. Its signature is a resonance peak in the spectrum of magnetic excitations in good agreement with results from inelastic neutron scattering. Furthermore we investigate the influence of antiferromagnetic order on the formation of the resonance peak. We find that its intensity is enhanced due to intraband transitions induced by the reconstruction of Fermi surface sheets. We determine the dispersion of the resonance peak near $\mathbf{Q}$ and show that it is dominated by the magnetic exciton dispersion associated with local moments. We demonstrate by a microscopic calculation that UPd_2Al_3 is another example in which the unconventional nature of the superconducting order parameter can be probed by means of inelastic neutron scattering (INS) and determined unambiguously.

TT 17.14 Wed 17:30 H18

Magnetic Phase Diagram of the Doped 2D Kondo Lattice Model: a DCA calculation — •Lee C. Martin and Fakher F. Assaad — Universität Würzburg, Germany

We apply an antiferromagnetic symmetry breaking implementation of the dynamical cluster approximation (DCA) to the two-dimensional hole-doped Kondo lattice model with hopping t and coupling J.

Precise calculations of single particle spectral functions compare well with exact BSS results at the particle-hole symmetric point. However, our DCA version, combined with a QMC cluster solver, also allows simulations away from particle-hole symmetry and has enabled us to map out the magnetic phase diagram of the model as a function of doping, coupling J/t and band structure.

At half-filling, our results show that the linear behaviour of the quasi-particle gap at small values of J/t is a direct consequence of particle-hole symmetry, which leads to nesting of the Fermi surface. Breaking the symmetry, by inclusion of a diagonal hopping term, results in a greatly reduced gap which appears to follow a Kondo scale.

Upon doping the magnetic phase observed at half-filling survives and ultimately gives way to a paramagnetic phase. Across this magnetic order disorder transition, we track the topology of the Fermi surface.

TT 17.15 Wed 17:45 H18

Berechnung von Spektralfunktionen stark korrelierter 5f-Systeme — •Martin Reese und Gertrud Zwicknagl — Institut für Mathematische Physik, Technische Universität Braunschweig, Braunschweig

Es werden Aktinidsysteme mit stark korrelierten 5f-Elektronen mit orbitaler Entartung betrachtet. Der verwendete Ansatz kombiniert die Ergebnisse aus ab-initio Elektronenstrukturrechnungen mit Clusterstörungsrechnungen an zweidimensionalen Clustern. Dieses Vorgehen gestattet es, die komplexen Korrelationen angemessen zu berücksichtigen. Die berechneten Spektren zeigen sowohl dispersive Quasiteilchenbänder als auch inkohärente lokale Anregungen. Die Ergebnisse der Rechnungen sind in guter qualitativer Übereinstimmung mit experimentell gewonnenen Daten aus Photoemissionsspektroskopie.

TT 18: Nanoelectronics I - Quantum Dots, Wires, Point Contacts

Time: Wednesday 14:00–17:15 Location: H19

TT 18.1 Wed 14:00 H19

Charge transfer statistics through multi-terminal Kondo and Anderson impurities — •Andrei Komnik[1], Thomas Schmidt[1], and Alexander Gogolin[2] — [1]Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Hermann-Herder-Str. 3, 79104 Freiburg — [2]Department of Mathematics, Imperial College London, 180 Queen's Gate, London SW7 2AZ, United Kingdom

We investigate the charge transfer statistics through a quantum dot in the Kondo regime coupled to an arbitrary number of terminals. Using the effective Hamiltonian valid at energies far below the Kondo temperature we calculate the generating function for the full counting statistics (FCS) perturbatively in the leading irrelevant operators. The transport seems to be mediated not only by single electron tunnelling but by correlated transport of electron pairs as well. We propose a measurement of cross correlations of Hanbury Brown and Twiss type in a multi-terminal geometry which is able to explicitly discern both processes in experiments. Furthermore we make predictions for generalised Fano factors to be universal and parameter-free. By comparison of perturbative expansions for weak and strong couplings we make predictions for the FCS of a more realistic multi-terminal Anderson impurity model, which are valid at all energy scales as long as the applied transport voltage is small.

TT 18.2 Wed 14:15 H19

Co-tunneling effects in transport through interacting quantum dots — •Jasmin Aghassi[1,2], Matthias Hettler[1], and Gerd Schön[1,2] — [1]Forschungszentrum Karlsruhe, INT, Postfach 3640, 76201 Karlsruhe — [2]Institut für theoretische Festkörperphysik, Universität Karlsruhe, 76128 Karlsruhe

We study charge transport in quantum dot systems within a diagrammatic technique. The current-voltage characteristics as well as the current noise are calculated within second-order perturbation expansion in the coupling parameter Γ. We allow for an intermediate coupling regime up to coupling constants of $\Gamma = k_B T$, where k_B is the Boltzmann constant and T the temperature. We explicitly account for intra- and inter-dot Coulomb interactions and the resulting many-body states of the quantum dots. For a single multilevel quantum dot we investigate the co-tunneling effects on the conductance and noise of the system in dependence of an applied gate voltage. In the Coulomb blockade region super-Poissonian noise is observed at the inelastic co-tunneling energy scale. This energy scale is also observable in the conductance in some cases. For non-local systems such as chains of coupled quantum dots ("artificial molecules") sequential tunneling results for transport under asymmetric conditions, i.e. non-resonant dots or asymmetric couplings are compared to second order results.

A. Thielmann *et.al.*, Phys. Rev. Lett., **95**, 146806 (2005)
J. Aghassi *et.al*, Appl. Phys. Lett. **89**, 052101 (2006), Phys. Rev.B **73**, 195323 (2006)

TT 18.3 Wed 14:30 H19

Frequency dependent quantum shot noise — •Jan C. Hammer and Wolfgang Belzig — University of Konstanz, Department of Physics, 78457 Konstanz, Germany

We study frequency-dependent quantum shot noise in the coherent charge transport through a double barrier quantum dot. In the framework of the scattering formalism we show how electron transport through such a Fabry-Perot-like setup reveals a super-Poissonian and an asymmetric noise spectrum for large frequencies. It depends on the applied bias voltage, the structure of the energy levels inside the scattering region and the coupling to the leads. For example, well separated energy levels lead to steps in the noise due to the emission and absorption of photons which get washed out as the width of the levels broadens. These can be shifted with respect to frequency by varying a gate voltage. At low frequency the Fano factor gets reduced and the spectrum is found to be symmetric.

TT 18.4 Wed 14:45 H19

Generation of Nonlocal Spin Entanglement in Nonequilibrium Quantum Dots — •Stefan Legel[1], Jürgen König[2], Guido Burkard[3], and Gerd Schön[1] — [1]Institut für Theoretische Festkörperphysik and DFG-Center for Functional Nanostructures (CFN), Universität Karlsruhe — [2]Institut für Theoretische Physik III, Ruhr-Universität Bochum — [3]Department of Physics and Astronomy, University of Basel

We propose schemes for generating nonlocal spin entanglement in systems of two quantum dots with onsite Coulomb repulsion weakly coupled to a joint electron reservoir. In nonequilibrium situations with one extra electron on each dot, we find the double-dot system in so-called Werner states with a fidelity exceeding 1/2, which indicates spin entanglement. We consider two specific setups. In the first setup we study the transient behavior of the system after rapidly pushing the dot levels from above to below the Fermi energy of the joint lead. We find the formation of an enhanced probability of the singlet state as compared to the triplet. In the second setup we analyze the stationary state with an applied bias voltage between the joint reservoir and two additional leads, which are weakly coupled to the dots. Depending on the polarity of the bias, we find an enhanced probability for either the singlet or the triplet states.

TT 18.5 Wed 15:00 H19

Non-equilibrium Josephson current through interacting quantum dots — •Marco G. Pala[1], Michele Governale[2], and Jürgen König[2] — [1]IMEP-MINATEC (UMR CNRS/INPG/UJF), F-38049 Grenoble, France — [2]Institut für Theoretische Physik III, Ruhr-Universität Bochum, D-44780 Bochum, Germany

We study transport through a quantum dot weakly coupled to both normal and superconducting leads. To this aim, we generalize a diagrammatic real-time transport theory[1] to account for superconductivity in the leads. In particular, we consider a system consisting of a quantum dot tunnel coupled to one normal and two superconducting leads. A finite voltage can be applied between the normal and the superconducting leads to drive the dot out of equilibrium. The dot is described by a single, spin-degenerate level, with arbitrary Coulomb

repulsion U. The tunnel coupling to the superconducting leads induces a coherent superposition of the empty and doubly occupied dot states (proximity effect). In turn, this may mediate a Josephson current between the two superconductors. We find a situation in which the Josephson current is switched on due to the interplay of Coulomb interaction and non-equilibrium in the dot.

[1] J. König, H. Schoeller, and G. Schön, Phys. Rev. Lett. **76**, 1715 (1996)

TT 18.6 Wed 15:15 H19

Adiabatic pumping through interacting quantum dots: A perturbation expansion in the tunnel coupling — •Janine Splettstoesser[1,2], Michele Governale[2], Jürgen König[2], and Rosario Fazio[1,3] — [1]Scuola Normale Superiore, Pisa, Italy — [2]Theoretische Physik III, Ruhr-Universität Bochum, Germany — [3]SISSA, Trieste, Italy

We present a diagrammatic real-time approach [1,2] to adiabatic pumping of electrons through interacting quantum dots. Performing a systematic perturbation expansion in the tunnel-coupling strength, we compute the charge pumped through a single-level quantum dot per pumping cycle. The combination of Coulomb interaction and quantum fluctuations, accounted for in contributions of higher order in the tunnel coupling, modifies the pumping characteristics via an interaction-dependent renormalization of the quantum-dot level. The latter is even responsible for the *dominant* contribution to the pumped charge when pumping via time-dependent tunnel-coupling strengths.[3]

[1] J. König, H. Schoeller, and G. Schön, Phys. Rev. Lett.**76**, 1715 (1996). [2] J. König, J. Schmid, H. Schoeller, and G. Schön, Phys. Rev. B **54**, 16820 (1996). [3] J. Splettstoesser, M. Governale, J. König, R. Fazio, Phys. Rev. B **74**, 085305 (2006).

TT 18.7 Wed 15:30 H19

Adiabatic Pumping through Metallic Single-Electron Devices — •Nina Winkler, Michele Governale, and Jürgen König — Institut für Theoretische Physik III · Ruhr-Universität Bochum

In a mesoscopic system a DC current can be generated even at zero bias voltage by periodically changing some of its properties in time. This transport mechanism is called pumping. If the time dependence of the parameters is slow compared to the internal time scales of the system, pumping is adiabatic.

In analogy to Ref. [1], we develop a diagrammatic real-time approach to adiabatic pumping through a system of tunnel-coupled metallic islands, performing a systematic perturbative expansion in powers of the tunnel-coupling strengths. This method allows us to identify the different physical processes which contribute to the pumped charge.

We first apply our formalism to a single-electron transistor consisting of one metallic island with Coulomb interaction tunnel coupled to two non-interacting leads. We compute the pumped charge up to first order in the tunnel-coupling strength, finding that the contribution in first order is due to the renormalisation of the charging-energy gap. For the case of pumping with the two tunnel-coupling strengths, this term becomes the dominant one. Furthermore, we consider pumping with the charging-energy gaps in a system consisting of two tunnel-coupled metallic islands. We calculate the pumped charge through this system, and investigate the issue of pumped-charge quantisation.

[1] J. Splettstoesser, M. Governale, J. König, and R. Fazio, Phys. Rev. B **74**, 085305 (2006).

15 min. break

TT 18.8 Wed 16:00 H19

Nonadiabatic electron heat pump — •Sigmund Kohler[1], Michael Strass[1], Peter Hänggi[1], Miguel Rey[1,2], and Fernando Sols[3] — [1]Institut für Physik, Universität Augsburg — [2]Universidad Autónoma de Madrid, Spain — [3]Universidad Complutense de Madrid, Spain

When operating a quantum pump in the nonadiabatic regime, electrons can absorb photons and, thus, be scattered to states with a higher energy. Such processes may create thermal energy in the attached leads. At non-zero temperature, also the opposite is possible, namely substantial scattering to low-energy states. Thus the question arises whether in principle it is possible to achieve cooling in that way. We propose a setup in which the energy balance in one lead is indeed negative, which amounts to cooling the lead. This "quantum refrigerator" can operate at zero net electrical current as it replaces hot by cold electrons through two energetically symmetric inelastic channels. We present numerical results for a specific heterostructure and discuss general trends.

[1] M. Rey, M. Strass, S. Kohler, P. Hänggi, and F. Sols, cond-mat/0610155.

TT 18.9 Wed 16:15 H19

Linear and nonlinear transport across carbon nanotube quantum dots — •Leonhard Mayrhofer and Milena Grifoni — Theoretische Physik, Universität Regensburg, 93040 Regensburg, Germany

We present a low energy-theory for non-linear transport in finite-size interacting single-wall carbon nanotubes. It is based on a microscopic model for the interacting p_z electrons and successive bosonization. We consider weak coupling to the leads and derive equations of motion for the reduced density matrix. We focus on the case of large-diameter nanotubes where exchange effects can be neglected. In this situation the energy spectrum is highly degenerate. Due to the multiple degeneracy, diagonal as well as off-diagonal (coherences) elements of the density matrix contribute to the nonlinear transport. At low bias, a four-electron periodicity with a characteristic ratio between adjacent peaks is predicted. Our results are in quantitative agreement with recent experiments.

[1] L. Mayrhofer, M. Grifoni, Phys. Rev. B **74**, 121403(R) (2006).
[2] L. Mayrhofer, M. Grifoni, cond-mat/0612286 (2006).

TT 18.10 Wed 16:30 H19

Transport properties of double-wall nanotubes in parallel magnetic field — •Magdalena Marganska, Shidong Wang, and Milena Grifoni — Institut für Theoretische Physik, Universität Regensburg, 93040 Regensburg, Germany

We study the quantum transport in disorder-free double-wall carbon nanotubes in the presence of a parallel magnetic field. The diffusion exponent, both spectrum-averaged and as a function of energy is obtained by calculating the multi-fractal dimension of the energy spectrum in the corresponding energy range. In the absence of the magnetic field the spreading of a wave packet along the nanotube can be ballistic or anomalous diffusive depending on the degree of incommensurability between shells and on the considered energy range. The coupling between shells is modified by the magnetic field via the Peierls phase, which causes a change in the energy spectrum. This has a complex structure, periodic in B, which depends on the relative chiralities of the shells.

TT 18.11 Wed 16:45 H19

Commensurate-incommensurate transition in 1D Coulomb drag — •Markus Garst[1], Leonid Glazman[2], and Ady Stern[3] — [1]Institut für Theoretische Physik, Universität zu Köln, 50937 Köln — [2]Theoretical Physics Institute, University of Minnesota, Minneapolis, MN 55455, USA — [3]Department of Condensed Matter Physics, The Weizmann Institute of Science, Rehovot 76100, Israel

Coulomb interaction between electrons of two parallel conducting wires results in a drag effect which is able to reveal various strong interaction effects. When the electron densities in the two wires are commensurate the system is unstable with respect to the formation of an interwire charge density wave (CDW). If the difference of electron densities exceeds a critical value the system undergoes a commensurate-incommensurate quantum phase transition, which can be tuned for example by an external gate voltage. We identify the critical theory governing this transition. We calculate the critical Coulomb drag effect and find that the drag resistance is given by an universal function of temperature and commensurability.

TT 18.12 Wed 17:00 H19

The conductance of a multi-mode ballistic ring: Beyond Landauer and Kubo — •Swarnali Bandopadhyay[1], Yoav Etzioni[2], and Doron Cohen[2] — [1]MPIPKS Dresden, Nöthnitzer Str. 38, 01187 Dresden — [2]Department of Physics, Ben-Gurion University, Beer-Sheva 84105, Israel

The calculation of the conductance of ballistic rings requires a theory that goes well beyond the Kubo-Drude formula [S. Bandopadhyay, Y. Etzioni and D. Cohen, Europhys. Lett. 76, 739 (2006)]. Assuming mesoscopic circumstances of very weak environmental relaxation, the conductance is much smaller compared with the naive expectation. Namely, the electro-motive force induces an energy absorption with a rate that depends crucially on the possibility to make connected

sequences of transitions. Thus the calculation of the mesoscopic conductance is similar to solving a percolation problem. The percolation is in energy space rather than in real space. Non-universal structures and sparsity of the perturbation matrix cannot be ignored. The latter are implied by lack of quantum-chaos ergodicity in ring shaped ballistic devices.

TT 19: Symposium "Terahertz Detectors"

Time: Wednesday 14:00–18:00 Location: H20

Invited Talk TT 19.1 Wed 14:00 H20

Superconducting detectors and mixers for submillimeter astrophysics — •Jonas Zmuidzinas — California Institute of Technology, 320-47, Pasadena, California 91125, USA

Fueled by advances in technology and instrumentation, astrophysics at submillimeter wavelengths has been transformed over the past three decades from a small effort at the fringes of the science into one of its major disciplines. Early developments focused on the superconducting tunnel junction (SIS) mixer, which was invented in the late 1970's and motivated the international ALMA project now being constructed in Atacama, Chile. A second superconducting mixer technology, the hot electron bolometer (HEB) mixer, rose to prominence during the 1990's and allows access to the THz frequencies beyond the reach of SIS devices; both SIS and HEB mixers are used in the HIFI instrument for ESA's 3.5 meter Herschel Space Observatory. In parallel, a technological revolution in submillimeter imaging detector arrays is underway, highlighted by the UK's SCUBA 2 project which relies on superconducting devices for its 10,000 pixel bolometer arrays (TES) and multiplexing electronics (SQUIDs). The TES/SQUID technology is being followed by a new generation of devices, such as the microwave kinetic inductance detector (MKID), and collectively these advances motivate the construction of a large (25m) single-dish telescope in Atacama, CCAT. This review will discuss the history and current status of the field, the interrelationsip between technological and astronomical advances, and the connections to other areas of research.

Invited Talk TT 19.2 Wed 14:40 H20

Superconducting detectors for low-background far infrared space astronomy — •Philip Mauskopf — School of Physics and Astronomy, Cardiff University, Queen's Buildings, Cardiff CF 24 3AA, UK

The next generation of far infrared astronomy satellites will have cooled telescopes to reduce the thermal background to very low levels. In order to take advantage of the low background, arrays of sensitive detectors will be needed, with NEPs of 10^{-19} W/$\sqrt{\text{Hz}}$ or less - more than an order of magnitude better than can be achieved using conventional photoconductive detectors. We will review the technical requirements for such arrays and report on the development of transition edge superconducting detectors and kinetic inductance detectors suitable for use with an imaging spectrometer instrument in the 40-200 micron region.

TT 19.3 Wed 15:20 H20

Terahertz detectors using hot-electrons in superconducting films — •Alexei Semenov — DLR Institute of Planetary Research, Berlin, Germany

Recently the terahertz gap has been recognized as a prospective spectral range for radoiastronomy as well as for material and security studies. Implementation of terahertz technology in these fields requires further improvement of instruments and their major subcomponents. Physical phenomena associated with the local and homogeneous non-equilibrium electron sates in thin superconducting films offer numerous possibilities for the development of terahertz and infrared detectors. Depending on the nature of the resistive state and the operation regime, a variety of detector can be realized. They are e.g. direct bolometric or kinetic inductance detectors, heterodyne mixers or photon counters. Operation principles and physical limitations of these devices will be discussed. Two examples of the detector development made in cooperation between the German Aerospace Center, the University of Karlsruhe and PTB, Berlin will be presented. The energy resolving single-photon detector with an almost fundamentally limited energy resolution of 0.6 eV at 6.5 K for photons with wavelengths from 400 nm to 2500 nm and the heterodyne mixer quasioptically coupled to radiation in the frequency range from 0.8 THz to 5 THz and providing a noise temperature of less then ten times the quantum limit. The mixers will be implemented in the terahertz radar for security screening (TERASEC) and in the heterodyne receiver of the stratospheric observatory SOFIA.

TT 19.4 Wed 15:50 H20

SIS and HEB Devices for THz Frequency Mixer Applications — •Karl-Friedrich Schuster — IRAM, 300 Rue de la Piscine, 38406 St Martin d'Heres, France

Heterodyne mixers using superconducting tunnel (SIS) junctions or hot electron bolometers (HEB) are among the most successfully used superconducting devices and play a key role in ongoing and future projects for space and ground based astronomy in the THz range. Introduced already 20 years ago SIS junctions for frequency mixing still undergo important developments which prepare the ground for optimized device performance and functionality. While SIS mixers are used in the domain up to 1 THz, mixers using hot electron bolometers are particularly well suited for the higher THz range. I will present a short overview on the current development goals for both mixer device types and then discuss the technological challenges within the fabrication process and the underlying physical questions.

10 min. break

TT 19.5 Wed 16:30 H20

Terahertz Bolometer Arrays for APEX — •Ernst Kreysa — MPIfR, Bonn, D

The Atacama Pathfinder Experiment (APEX) is a new terahertz telescope in the southern hemisphere. It is situated at an altitude of 5100 m, on Llano de Chajnantor in the Chilean Andes, where the atmospheric transmission is superb during a significant fraction of the year. The site is so dry that observations in the atmospheric window at 1.5 THz are feasible. With a diameter of 12 m and a surface of 18 micron rms, APEX is presently the most powerful terahertz telescope. At the Cassegrain focus, its field of view extends to about half a degree, making it very suitable for large scale mapping. The challenge for large terahertz bolometer arrays at APEX is that the Cassegrain cabin is so small. It also has only limited access and will tilt in elevation during observations. Sub-Kelvin cryogenic coolers or cryostats have to work under these conditions reliably and remotely. A first generation instrument, the large bolometer camera (LABOCA-1) with 295 bolometers for 345 GHz is being commissioned. While LABOCA-1 is still based on semiconductor thermistors, there can be no doubt that for really large arrays, superconducting bolometers with multiplexed SQUID readout are required. This new technology is being demonstrated with a small array of 40 bolometers for 0.85 THz. Results of these developments, carried out in cooperation between the Max-Planck-Institute for Radioastronomy (MPIfR) in Bonn and the Institute for Physical High Technology (IPHT) in Jena, will be presented.

TT 19.6 Wed 17:00 H20

FIR Detectors for Herschel and SOFIA — •Albrecht Poglitsch[1], P. Agnese[2], L. Barl[1], N. Billot[3], O. Boulade[3], L. Duband[4], U. Groezinger[5], R. Hoenle[1], and P. Merken[6] — [1]MPE, Garching, Germany — [2]LETI, Grenoble, France — [3]CEA, Saclay, France — [4]CEA, Grenoble, France — [5]MPIA, Heidelberg, Germany — [6]IMEC, Leuven, Belgium

We report the development of new, large format detectors for the 50 - 200 micron wavelength range for use in cameras and spectrometers.

The lowest detector noise, needed for background-noise limted spectroscopy, is achieved with Ge:Ga photoconductor arrays. These arrays are based on individual Ge:Ga detectors contained in integrating cavities. In order to detect light at wavelengths >120 microns, uniaxial stress is applied to each detector crystal. In combination with their cryogenic readout circuits, these detectors reach effective quantum efficiencies of >30% under representative background conditions, or NEPs

down into the 10^-18 W/sqrt(Hz) range.

For the higher background experienced in photometry we have developed 3-sides buttable bolometer arrays. They represent the first monolithic filled arrays of bolometers with a cold multiplexed readout. They have been optimised for both, high FIR absorption efficiency and minimum cross section to cosmic rays for operation in a space environment. The bolometers, working at a temperature of 300mK with a dedicated 3He cooler, have an NEP of ~10^-16 W/sqrt(Hz) and a post-detection bandwidth of 4 to 5 Hz.

TT 19.7 Wed 17:30 H20

A superconducting Terahertz imager — •Torsten May[1], Viatcheslav Zakosarenko[1], Solveig Anders[1], Hans-Georg Meyer[1], Günther Thorwirth[2], Ernst Kreysa[3], and Nikhil Jethava[3] — [1]IPHT Jena e.V., Albert-Einstein-Str. 9, 07745 Jena — [2]Jena Optronik GmbH, Prüssingstr. 21, 07745 Jena — [3]Max-Planck Institut für Radioastronomie, Auf dem Hügel 69, 53121 Bonn

Mapping objects at frequencies around one terahertz from a significant distance poses a considerable challenge for any imaging device. The power emission of bodies at room temperature is very weak, so a purely passive map requires an extremely sensitive detector. For sub-mm wavelength recently a big leap forward in the detector performance and scalability was driven by the astrophysics community. Superconducting bolometers and midsized arrays of them have been developed and are in routine use. It is conceivable that such devices will become larger, less costly and available for a wider market. So, a THz imager for industrial or security applications based on superconducting detectors comes into reach. Although devices with many pixels are foreseeable nowadays a device with an additional scanning optic is the straightest way to an imaging system with a useful resolution. Our superconducting THz imager (SCOTI) is a small cassegrain telescope with a scanning secondary mirror designed for a frequency of 0.34 THz. It can map objects from a distance between 5 meters and 20 meters using a small array of superconducting bolometers. The resolution at the object area is about 1 cm. Purely passive images of interesting objects can be taken, opening a wide field of applications.

TT 20: Correlated Electrons - Poster Session

Time: Wednesday 14:00–17:45 Location: Poster A

TT 20.1 Wed 14:00 Poster A

Neutron Scattering and X-ray Diffraction on $HoInCu_4$ — •Veronika Fritsch[1,3], Svilen Bobev[2], John L. Sarrao[3], Uwe Amann[4,5], and Oliver Stockert[6] — [1]Physikalisches Institut, Universität Karlsruhe, 76128 Karlsruhe, Germany — [2]Department of Chemistry, University of Delaware, Newark, DE 19716, USA — [3]Los Alamos National Laboratory, Los Alamos, NM 87545, USA — [4]BENSC, HMI, 14109 Berlin, Germany — [5]Institut für Angewandte Physik, Universität Tübingen, 72076 Tübingen, Germany — [6]MPI-CPfS, 01187 Dresden, Germany

The ternary rare-earth compounds $R\mathrm{InCu}_4$ (R = Gd, Dy, Ho and Er) show strong indications of frustration as manifested by measurements of magnetic susceptibility and specific heat. The crystal structure, in which the rare-earth ions occupy a face-centered cubic lattice, suggests the presence of geometrical frustration. In order to get further insight into the crystal and magnetic structure we performed X-ray diffraction measurements on flux-grown single crystals and neutron diffraction measurements on powder of $HoInCu_4$. Single crystal X-ray diffraction data confirmed that the samples are fully ordered, all atoms occupy crystallographically independent sites and crystallize in the cubic $AuBe_5$-structure. $HoInCu_4$ exhibits magnetic order below $T_N = 0.75$ K as evidenced by heat capacity measurements. Neutron diffraction patterns were taken above and below the Néel temperature, indicating a commensurate magnetic structure with a propagation vector $\tau = (1\ 1/2\ 0)$ below T_N as well as strong magnetic correlations in the paramagnetic state as expected in systems with strong frustration.

TT 20.2 Wed 14:00 Poster A

Spin Dynamics of $EuCu_2(Ge_{(1-x)}Si_x)_2$ probed by Electron Spin Resonance — •Tobias Foerster[1], Joerg Sichelschmidt[1], Zakir Hossain[2], and Christoph Geibel[1] — [1]Max Planck Institut f. Chemische Physik Fester Körper, Nöthnitzer Str. 40, 01187 Dresden, Germany — [2]Department of Physics, Indian Institut of Technology, Kanpur, India

The intermetallic alloy $EuCu_2(Ge_{(1-x)}Si_x)_2$ can be used to investigate the transition from divalent antiferromagnetic state to the valence fluctuating state of Eu. By tuning x one observes an antiferromagnetic ordered state which is stable up to $x_c \approx 0.65$. For $x > 0.5$ the system shows valence fluctuation behaviour. Additionally, for $x > 0.4$ Kondo-like behaviour appears, becoming pronounced around x_c where also heavy Fermi liquid formation is observed.
We investigated polycrystalline samples of $EuCu_2(Ge_{(1-x)}Si_x)_2$ ($0 \leq x \leq 1$) by Electron Spin Resonance (ESR) at X-Band frequencies. All compositions show well defined ESR spectra at a g-factor typical for Eu^{2+} ions. We observe different temperature dependencies of the line width in different regions of the phase diagram. For example the sample with $x = 0.6375$ shows a line width increase for rising temperature with a change of slope near the estimated Kondo temperature, $T_K \approx 30K$. This behaviour is very similar to the pattern observed for ESR probe spins embedded in a Kondo lattice system. The ESR spectra are analyzed concerning the backround of bulk measurements.

TT 20.3 Wed 14:00 Poster A

Boron induced change of valence state of Eu in $EuPd_3B_x$ ($0 \leq x \leq 0.55$) — •Roman Gumeniuk, Claire Loison, Andreas Leithe-Jasper, Walter Schnelle, Ulrich Burkhardt, Marcus Schmidt, Miriam Schmitt, Ulrich Schwarz, and Helge Rosner — Max-Planck-Institut für Chemische Physik fester Stoffe, Dresden, Germany

A detailed experimental and theoretical study of the solubility of B in cubic $EuPd_3$ ($AuCu_3$ structure type) and its influence on the physical properties is presented here. Theoretical calculations (LDA + U + CPA method) predict in $EuPd_3B_x$ a change of non-magnetic $4f^6$ Eu to magnetic $4f^7$ Eu for a boron content of $x > 0.2$ together with an anomaly in the unit cell volume. At 950°C the incorporation of B in the structure of $EuPd_3B_x$ is possible up to $x = 0.55$, as can be concluded from measurements of lattice parameters, WDXS and chemical analyses. The lattice parameter of $EuPd_3B_x$ varies linearly with B content (x) with a distinct change of slope at $x = 0.31$. From Eu L_{III} XAS studies as well as from measurements of magnetic susceptibility it can be deduced that Eu atoms in $EuPd_3$ and in $EuPd_3B_x$ ($0 \leq x \leq 0.31$) exhibit a $4f^6$ state, while for $EuPd_3B_x$ ($0.31 \leq x \leq 0.55$) an intermediate valence state of (mixed $4f^6$ and $4f^7$) can be assumed. Our findings are discussed with respect to previously published studies [1,2].
[1] B. Darshan *et al.* Phys. Rev. B **30** (1984) 4031-4033.
[2] S. K. Dhar *et al.* Phys. Rev. B **29** (1984) 5953-5956.

TT 20.4 Wed 14:00 Poster A

Coexistence of ferromagnetism and underscreened Kondo effect in uranium compounds — •Natalia Perkins[1], Jose Roberto Iglesias[2], and Bernard Coqblin[3] — [1]Technische University of Braunschweig, Braunschweig,38106, Germany — [2]Instituto di Fisica, Universidade Federal do Rio Grand do Sul, 91501-970, Porto Alegre, Brazil — [3]Laboratoire de Physique des Solides, Universite Paris-Sud, Batiment 510, 91405 Orsay, France

Coexistence between ferromagnetic order and Kondo behavior has been experimentally observed in some uranium compounds, like UTe or UCu0.9Sb2. This is an unusual behavior as Kondo effect generally compete with magnetic order, for instance in Ce compounds. Here we propose underscreened Kondo lattice model, including localized S=1 spins which couple to conduction electron through an on-site Kondo coupling, while interacting among them ferromagnetically. Results are obtained for different temperatures and values of the band filling and they show that the Kondo temperature is larger than the Curie temperature, suggesting a scenario for the coexistence of Kondo effect and ferromagnetic order.

TT 20.5 Wed 14:00 Poster A

Detailed studies of the resistive superconducting transition in UNi_2Al_3 thin films — •Michael Foerster, Martin Jourdan, Andrey Zakharov, and Hermann Adrian — Johannes Gutenberg-Universität, Institut für Physik, Mainz, Germany

Some time ago a dependence of the resistive superconducting transition temperature on the current direction in UNi_2Al_3 thin films was observed. Although a qualitative explanation can be given, fundamental questions about this phenomenon are still open, which motivated more detailed studies.

Morphological investigations by AFM and STM seem to rule out a growth mechanism induced origin. By using a specially designed photomask we were able to measure the transition down to current densities of 0.1 A/cm^2 and observed no vanishing of the difference in T_c. However, the magnitude of the splitting of the sc transition varies from sample to sample without any correlation to the defect density as determined by the residual resistance ratio. V(I) characteristics in the superconducting state were measured at various magnetic fields, indicating anisotropic pinning. For the current direction I‖c a thermally activated flux flow region could be identified.

Additional measurements with higher current densities prove that the observations in the relevant range are not generated by heating effects. The shift in T_c as a function of current density agrees well with the expectation for pairbreaking critical current from Ginzburg-Landau theory.

TT 20.6 Wed 14:00 Poster A

Magnetic order in $CeIn_{3-x}Sn_x$ investigated by μSR measurements — •Julia Arndt[1], Astrid Schneidewind[2], Oliver Stockert[1], Daniel Andreica[3], Nubia Caroca-Canales[1], Christoph Geibel[1], and Michael Loewenhaupt[2] — [1]MPI f. Chemische Physik fester Stoffe, D-01187 Dresden — [2]Inst. f. Festkörperphysik, TU Dresden, D-01062 Dresden — [3]Laboratory for Muon Spin Spectroscopy, PSI, CH-5232 Villigen

We report on zero-field muon spin rotation (μSR) measurements on single crystals of the cubic heavy-fermion compound $CeIn_{3-x}Sn_x$. $CeIn_3$ orders antiferromagnetically below $T_N = 10.2$ K. Substituting Sn for In suppresses the magnetic order until $T_N = 0$ at a critical concentration $x_c = 0.67$ [1]. For $x < 0.2$ the specific heat C exhibits the typical λ shaped anomaly at T_N, whereas for $x > 0.2$ C shows a broad maximum in the vicinity of the phase transition, which is taken as a sign for a change in the magnetic structure [2]. So far it has not been accomplished to detect magnetic intensity by means of neutron scattering in this region [3]. In contrast, μSR with its sensitivity to small local magnetic fields in the sample gives the opportunity to probe if magnetic order is present for $x > 0$ at all. All $CeIn_{3-x}Sn_x$ samples investigated ($x = 0; 0.2; 0.4; 0.55$) show a Kubo-Toyabe shaped μSR signal with high depolarisation below T_N and very weak damping above. This is interpreted as the first detection of a clear signature of magnetic order in $CeIn_{3-x}Sn_x$ for $x > 0$.

[1] T. Rus *et al.*, Physica B, **359-361**, 62 (2005); [2] P. Pedrazzini *et al.*, Eur. Phys. J. B, **38**, 445 (2004); [3] O.Stockert *et al.*, unpublished

TT 20.7 Wed 14:00 Poster A

Deposition of $CeCoIn_5$ thin films by co-sputtering and evaporation — •Jochen Geerk[1], Alexander Zaitsev[1], Rainer Fromknecht[1], Andre Beck[1], and Hilbert v. Löhneysen[1,2] — [1]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, P.O.B. 3640, D-76021 Karlsruhe, Germany — [2]Physikalisches Institut, Universität Karlsruhe

Thin films of the heavy fermion superconductor $CeCoIn_5$ were prepared on sapphire substrates with different orientations by combining sputtering (Ce and Co) and evaporation (In). The sputter targets of Ce and Co were arranged in a face-to-face geometry with a magnetic field applied perpendicular to the target surface thus providing an oscillatory movement of the secondary electrons between the targets the latter acting as electric mirrors. Indium was evaporated from a BN oven. In the course of our studies the composition of the films, controlled by RBS and EDX, was varied between ± 30 % for the three elements and the growth temperature ranged from 500 to 750 ° C. The films obtained so far showed transition temperatures between 1.5 and 2.0 K and the characteristic maximum in resistivity near 40 K.

TT 20.8 Wed 14:00 Poster A

High pressure resistivity studies on $YbIr_2Si_2$ — •Monica Macovei[1], Michael Nicklas[1], Cornelius Krellner[1], Zakir Hossain[2], Christoph Geibel[1], and Frank Steglich[1] — [1]Max Planck Institute for Chemical Physics of Solids, Nöthnitzer Str. 40, 01069 Dresden, Germany — [2]Departament of Physics, Indian Institute of Technology, Kampur 208016, India

We investigated the high pressure phase diagram on high-quality single crystals of $YbIr_2Si_2$. Electrical resistivity,ρ, was measured in the pressure range up to 10 GPa and for temperature 0.05 K $< T <$ 300 K. Ambient pressure specific heat and resistivity studies confirmed a Fermi liquid ground state below $\sim$ 200 mK [1]. The Fermi liquid ground state is persisting at low pressure $p < 2$ GPa. However, with further increasing pressure the low-temperature dependence of the resisitivity changes from a T^2 dependence to $\rho = \rho_0 + AT^n$ with $n < 2$, indicating non-Fermi liquid behavior. By applying a magnetic field the Fermi liquid ground state is stabilized again. For $p > 7$ GPa magnetic order is developing marked by a kink in resistivity similar like in other Yb based heavy fermion compounds, e.g. $YbRh_2Si_2$, $YbCu_2Si_2$ and $YbNi_2Ge_2$.

[1] Z.Hossain *et al.* Phys. Rev. B **72**, 094411 (2005).

TT 20.9 Wed 14:00 Poster A

$YbNi_2Si_3$: a new Yb based intermetallic compound — Alexander Cosceev[1], Marc Uhlarz[1], Thomas Wolf[2], Peter Adelmann[2], •Kai Grube[2], Peter Schweiss[2], Georg Roth[3], Rainer Fromknecht[2], Christoph Sürgers[1], and Hilbert v. Löhneysen[1,2] — [1]Physikalisches Institut, Universität Karlsruhe, Germany — [2]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, Germany — [3]Institut für Kristallographie, RWTH Aachen, Germany

We have synthesized a new intermetallic compound $YbNi_2Si_3$ which crystallizes in the space group *Immm* with the metric $a = 3.860$Å, $b = 3.862$Å, and $c = 24.068$Å. Single crystals have been grown from Sn flux in a closed SiO_2 glass ampoule. Clean free-standing crystals could be obtained after dissolving the solid flux with liquid gallium and cleaning with a solution of iodine in dimethyl formamide. The magnetic dc susceptibility was measured parallel and perpendicular to the c axis. We find a rather strong anisotropy of the Curie-Weiss-like susceptibility down to 2.3 K. Measurements of the specific heat will be reported as well.

TT 20.10 Wed 14:00 Poster A

High-field ESR on the Kondo-system $YbRh_2Si_2$ — •Uwe Schaufuss[1], V. Kataev[1], B. Büchner[1], J. Sichelschmidt[2], C. Krellner[2], C. Geibel[2], and F. Steglich[2] — [1]Leibniz Institute for Solid State and Materials Research IFW Dresden — [2]Max Planck Institute for Chemical Physics of Solids, Dresden

$YbRh_2Si_2$ is a Kondo–system with a Kondo temperature $T_K \sim 25$ K [1] . It is located very close to a quantum critical point related to a very weak AFM order below $T_N = 65$ mK and a critical magnetic field of $B_C = 0.06$ T at ambient pressure. Surprisingly an ESR signal typical of a local Yb^{3+} spin has been observed below T_K at fields $B \leq 0.7$ T [2] . The occurrence of the ESR signal is unexpected because at $T \ll T_K$ the Yb^{3+} moments should be screened. In order to obtain a deeper insight in this unusual behaviour we have performed ESR measurements on single crystals of $YbRh_2Si_2$ at much higher fields (5 to 7.5 T) at temperatures from 3 to 25 K, i.e. in the region where one expects a crossover from a Non–Fermi liquid(NFL) to a Fermi–liquid (FL) phase [3] . We observe a strongly anisotropic signal which can be assigned to Yb^{3+} moments. The signal exhibits a pronounced dependence on temperature and the magnetic field. We discuss the puzzling controversy between the observation of ESR which shows properties characteristic of a local Yb^{3+} moment and the Kondo state of $YbRh_2Si_2$.

1 O. Trovarelli *et al.*: Phys. Rev. Lett. **85,** 626 (2000)
2 J. Sichelschmidt *et al.*: Phys. Rev. Lett. **91,** 156 401 (2003)
3 K. Ishida *et al.*: Phys. Rev. Lett. **89,** 107 202 (2002)

TT 20.11 Wed 14:00 Poster A

Magnetotransport across the field-induced quantum phase transition in $CeCu_{5.8}Au_{0.2}$ — •Marc Uhlarz[1], Moritz Röger[1], Tihomir Tomanic[1], and Hilbert v. Löhneysen[1,2] — [1]Physikalisches Institut, Universität Karlsruhe (TH), D-76128 Karlsruhe — [2]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, D-76021 Karlsruhe

We report on magnetoresistivity and Hall effect of $CeCu_{0.58}Au_{0.2}$, magnetic field B applied along the hard direction (b axis in orthorhombic notation) and current I along the a axis. At $B = 0$, $CeCu_{0.58}Au_{0.2}$ orders antiferromagnetically below $T_N = 0.25$ K [1]. As observed previously [1], the longitudinal electrical resistivity $\rho_{xx}(T)$ rises towards lower T below T_N for current directions containing a component of the magnetic ordering vector $\mathbf{Q} = (0.625, 0, 0.275)$. With increasing B, the rise of $\rho_{xx}(T)$ becomes smaller and T_N shifts to lower T, vanishing at $B_c = 3.6$ T. Likewise, the field derivative of the transverse resistivity $\mathrm{d}\rho_{xy}/\mathrm{d}B$ (independent of B at high temperatures) becomes

field-dependent in the vicinity of B_c below T_N. This signals (in a simple single-band picture) an increase of the effective carrier concentration when B exceeds the critical field B_c of antiferromagnetic order. Our data will be compared to recent experiments on $YbRh_2Si_2$, where a kink of the Hall coefficient R_H at B_c was inferred for $T \to 0$ from the gradual change of slope of $\rho_{xy}(B)$ for finite T, becoming more pronounced for $T \to 0$ [2].

[1] H. v. Löhneysen et al., Eur. Phys. J. B **5** (1998) 447
[2] S. Paschen et al., Nature **432** (2004) 881.

TT 20.12 Wed 14:00 Poster A

DC-Susceptibility of $CeCu_{6-x}Au_x$ at very low temperatures — •Andreas Hamann[1], Tihomir Tomanic[1], Hilbert v. Löhneysen[1,2], and Oliver Stockert[3] — [1]Physikalisches Institut, Universität Karlsruhe, 76128 Karlsruhe — [2]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, 76021 Karlsruhe — [3]MPI für chemische Physik fester Stoffe, 01187 Dresden

$CeCu_6$ is a prototype heavy-fermion system that is rather well described by Fermi liquid (FL) theory. Au doping introduces long-range incommensurate antiferromagnetism for $x > x_c \approx 0.1$. In the vicinity of the quantum critical point x_c significant deviations from FL theory have been observed in measurements of the specific heat, magnetic susceptibility and the electrical resistivity. In addition, highly unusual features were observed in inelastic neutron scattering [1,2]. In particular, the energy integrated dynamical as well as the statical susceptibility could be described by $\chi^{-1} \propto (\theta(q))^\alpha + cT^\alpha$ with $\alpha = 0.75$ [1]. We report measurements of the low-field dc-susceptibility $\chi(T)$ of $CeCu_{5.9}Au_{0.1}$ and $CeCu_{5.85}Au_{0.15}$ down to temperatures around 40 mK. Our data for $x = 0.1$ show for $T \lesssim 200$ mK deviations from the above χ^{-1} expression signaling a crossover for a smaller exponent α than previously found for higher T and B. For $x = 0.15$ we see clear experimental evidence for the sharp onset of antiferromagnetic order below $T_N \approx 82$ mK for $x = 0.15$. We compare our data in detail with the previous work [1].

[1] A. Schröder et al., Nature 407, 6802 (2000)
[2] O. Stockert et al., Phys. Rev. Lett. 80, 5627 (1998)

TT 20.13 Wed 14:00 Poster A

Quantenphasenübergänge in $NbFe_2$ — •Carsten Albrecht[1], Manuel Brando[2], Will Duncan[1], Dennis Moroni-Klementowicz[1], Daniel Grüner[2], Rafik Ballou[3], Bjorn Fak[4], Guido Kreiner[2] und F. Malte Grosche[1] — [1]Dept. of Physics, Royal Holloway, University of London, Egham, UK — [2]MPI-CPfS, Nöthnitzer Str. 40, Dresden — [3]CNRS, Grenoble — [4]CEA DRFMC, SPSMS, Grenoble

Was geschieht mit metallischen Ferromagneten bei Annäherung an ihren quantenkritischen Punkt (QKP), wenn der magnetische Übergang kontinuierlich unterdrückt wird?

In einigen bisher untersuchten Fällen, insbesondere den stoichiometrischen Verbindungen MnSi und $ZrZn_2$, verdeckt die Wandlung zu Phasenübergängen 1. Ordnung den erwarteten QKP. Ein anderes Szenario wird möglicherweise in dem verwandten System $NbFe_2$ realisiert: $NbFe_2$ existiert dicht an der Schwelle zum Ferromagnetismus, erkennbar an seinem stark erhöhten Stonerfaktor $\simeq 120$ (bezogen auf die gerechnete Zustandsdichte), nimmt aber unterhalb von etwa 20 K vermutlich eine bisher nicht genau identifizierte Spindichtewellenordnung an. Sowohl leichter Fe- als auch leichter Nb- Überschuss im Bereich von einem Prozent führen zu itinerantem Ferromagnetismus. Unsere Untersuchungen an Proben aus den bisher identifizierten Bereichen des Zusammensetzungs-Phasendiagramms sowie eine Reihe von Hochdruckmessungen weisen darauf hin, dass in $NbFe_2$ der ferromagnetische QKP durch Wandlung von Ferromagnetismus zu langwellig modulierter Spindichtewellen- bzw. Spiralordnung verdeckt wird.

TT 20.14 Wed 14:00 Poster A

Magnetic-field-induced Change of the Fermi Surface in CeBiPt — •M Bartkowiak[1], B Bergk[1], Y Skourski[1], J Wosnitza[1], I Opahle[2], S Elgazzar[2], M Richter[2], H v Löhneysen[3,4], T Yoshino[5], and T Takabatake[5] — [1]Hochfeld-Magnetlabor Dresden (HLD) FZ Dresden-Rossendorf, 01328 Dresden — [2]IFW Dresden,PO Box 270116, 01171 Dresden — [3]Physikalisches Institut, Universität Karlsruhe — [4]Institut für Festkörperphysik, FZ Karlsruhe — [5]Department of Quantum Matter, ADSM, Hiroshima University

Comparative experiments between the two semimetals CeBiPt and LaBiPt reveal changes of the Fermi surface in CeBiPt with respect to temperature, applied magnetic, field and chemical composition. It must be concluded that the strong temperature dependence of the Shubnikov-de Haas (SdH) frequency as well as the change of carrier concentration above a sample dependent critical field are associated with the $4f$ electrons introduced by the Ce atoms. We present Hall and magnetoresistance measurements up to 70 T obtained at our new pulsed high magnetic field laboratory in Dresden. We observe the disappearance of the SdH signal and a change of the Hall coefficient above a sample-dependent threshold field. Rather than at 25 T, as reported previously, we measured a threshold field of ≈ 40 T demonstrating the strong dependence of the Fermi surface on stoichiometry.

TT 20.15 Wed 14:00 Poster A

Inelastic Neutron Scattering on the Antiferromagnetic Half-Heusler Alloy CeBiPt — •Gernot Goll[1], Oliver Stockert[2], Tobias Unruh[3], Peter Link[3], K. Shigetoh[4], and T. Takabatake[4] — [1]Physikalisches Institut, Universität Karlsruhe, 76128 Karlsruhe — [2]Max-Planck-Institut CPfS, 01187 Dresden — [3]ZWE FRM-II, Technische Universität München, 85747 Garching — [4]Hiroshima University, Higashi-Hiroshima, Japan

CeBiPt is a semimetal with a rather low charge carrier concentration $n = 7.7 \cdot 10^{17}\,\mathrm{cm}^{-3}$. Below $T_N \approx 1$ K antiferromagnetic order occurres as evidenced by sharp maxima in the thermodynamic properties. Neutron diffraction experiments have revealed an AF-type I structure with a propagation vector $\tau = (1\ 0\ 0)$ and moments also along [1 0 0]. The ordered moment $\mu \approx 0.6\,\mu_B$ is much lower than the effective moment determined from the Curie-Weiss behavior of the susceptibility at higher T. Crystal-electric field (CEF) splitting of the Ce^{3+} level might be one origin of a lowered ordered moment. We performed inelastic neutron scattering experiments on TOFTOF at the FRM-II with energy of the incident neutrons $E_i = 2.7$, 5.7, and 16.9 meV and on PANDA with $E_i = 5.6$ meV at $2.8 < T < 50$ K. We found only one CEF excitation at $\hbar\omega \approx 9.5$ meV at $T = 2$ K in line with previous measurements on SV29 at FRJ-2 with fixed $E_i = 30$ meV. This excitation has been identified with the transition between a Γ_7 doublet and a Γ_8 quartet state. No further inelastic excitations have been observed except for a quasielastic contribution which increases in width with increasing temperature.

TT 20.16 Wed 14:00 Poster A

Kondo effect in low-carrier systems — •Robert Hager and Ralf Bulla — Theoretische Physik III, Elektronische Korrelationen und Magnetismus, Institut für Physik, Universität Augsburg

Recent experiments on dilute U impurities in semiconducting CaB_6 show typical Kondo phenomena with a Kondo temperature $T_K \approx 2K$ (G.A. Wigger *et al.*, Europhys. Lett. **68**, 685 (2004)). This observation is rather unusual for magnetic moments due to 5f electrons because of the large hybridization between impurities and the conduction electrons. We perform numerical renormalization group calculations for an Anderson impurity model with a low concentration of conduction electrons, believed to be the relevant model for $(U,Ca)B_6$. We present results for thermodynamic and dynamic quantities for various carrier concentrations and investigate the crossover from mixed-valent to Kondo behaviour upon decreasing the filling of the conduction band.

TT 20.17 Wed 14:00 Poster A

Strong inhomogeneities and non-Fermi liquids in randomly depleted Kondo lattices — •Matthias Vojta[1] and Ribhu Kaul[2] — [1]Institut für Theoretische Physik, Universität Köln — [2]Physics Department, Harvard University

We discuss the low-temperature behavior of Kondo lattices upon random depletion of the local f moments. For a large range of intermediate doping levels, between the coherent Fermi liquid of the dense lattice and the single-impurity Fermi liquid of the dilute limit, we find strongly inhomogeneous states that exhibit distinct non-Fermi liquid characteristics. In particular, the interplay of dopant disorder and strong interactions leads to rare weakly screened moments which dominate the bulk susceptibility. Our results are relevant to compounds like $(Ce,La)CoIn_5$.

TT 20.18 Wed 14:00 Poster A

Unusual Single Ion Behavior in $CeNi_{8.6}Cu_{0.4}Ge_4$ near a Quantum Critical Phase Transition — •Ludwig Peyker[1], Ernst-Wilhelm Scheidt[1], Wolfgang Scherer[1], Stephan Kehrein[2], and Herwig Michor[3] — [1]Chemische Physik und Materialwissenschaften, Universität Augsburg, 86159 Augsburg, Germany — [2]Fakultät für Physik, LMU München, 80333 München, Germany — [3]Institut für Festkörperphysik, TU Wien, 1040 Wien, Austria

We report on specific heat and magnetic susceptibility measurements of the heavy fermion intermetallic system $CeNi_{9-x}Cu_xGe_4$ for various concentrations ranging from the stoichiometric compound with $x = 0$ to $x = 1$. $CeNi_9Ge_4$ reveals the largest ever recorded value of the electronic specific heat $\Delta C/T \approx 5.5\,\mathrm{J\,K^{-2}mol^{-1}}$ at $T = 80\,\mathrm{mK}$ without any magnetic order. This behavior is mainly driven by single ion (Ce) effects due to the competition between Kondo effect and crystal electrical field splitting [1]. Changing the environment of the magnetic ion Ce by replacing Ni with Cu leads to a long range antiferromagnetic order at $T_N = 180\,\mathrm{mK}$ for $CeNi_8CuGe_4$. In between $CeNi_{8.6}Cu_{0.4}Ge_4$ reveals a logarithmic temperature dependency in specific heat indicating non Fermi liquid behavior. This behavior will be discussed in a quantum critical phase transition scenario.

[1] U. Killer, E.-W. Scheidt, G. Eickerling, H. Michor, J. Sereni, Th. Pruschke, S. Kehrein, Phys. Rev. Lett. **92**, 27003 (2004)

TT 20.19 Wed 14:00 Poster A

Matrix Product States for comparing NRG to DMRG — •Hamed Saberi, Andreas Weichselbaum, and Jan von Delft — Arnold Sommerfeld Center for Theoretical Physics and Center for NanoScience, Ludwig-Maximilians-Universität, Munich, Germany

Wilson's Numerical Renormalization Group (NRG) method for solving quantum impurity models can be turned into a variational method within the set of so-called Matrix Product States (MPS) with much more flexibility and efficient use of numerical resources. Since White's Density Matrix Renormalization Group (DMRG) for treating quantum lattice problems can likewise be reformulated in terms of MPSs, the NRG and DMRG are now seen to have the same formal basis, namely both are built on MPS. This enables us to compare the NRG approach for the Single Impurity Anderson model to the DMRG approach and also to see how NRG results can be improved upon systematically by performing a variational optimization in a space of variational matrix product states of the same structure as those used by NRG.

TT 20.20 Wed 14:00 Poster A

Coupled-Cluster Method for the Anderson Impurity Model — •Jin-Jun Liang, Clive Emary, and Tobias Brandes — Sekr. PN 7-1, Institut für Theoretische Physik, Technische Universität Berlin, Hardenbergstr. 36, D-10623 BERLIN-Charlottenburg

The coupled-cluster method (CCM) is one of the most powerful and numerically accurate approximation method for describing many-body systems. It is popular in nuclear physics, quantum chemistry and quantum magnetism. However, the method has been rarely applied to the Anderson impurity model. Here with CCM, we calculate the model's energies and wave-functions for the ground state as well as some excited states. Results are compared with those from other methods, including self-consistent perturbation and variational methods.

TT 20.21 Wed 14:00 Poster A

Quantum Monte-Carlo scheme for the solution of the Kondo impurity problem with an arbitrary density of free electron states — •Evgeny Gorelov[1,2], Andrey Zhuravlev[1,3], Alexey Rubtsov[4], and Alexander Lichtenstein[1] — [1]I. Institut für theoretische Physik, Universität Hamburg, Jungiusstrasse 9, 20355 Hamburg — [2]Theoretical Physics and Applied Mathematics Department, Urals State Technical University, Mira Street 19, 620002 Ekaterinburg, Russia — [3]Institute of Metal Physics, 620219 Ekaterinburg, Russia — [4]Department of Physics, Moscow State University, 119992 Moscow, Russia

The numerically exact determinantal continuous time QMC method has been applied to calculate properties of a Kondo impurity coupled to a band of free electrons with an arbitrary density of states (DOS). This approach allows to calculate spin susceptibilities as well as Green functions, accurately taking into account all the peculiarities of the free electron DOS. The method was applied to a Kondo impurity embedded into different environments: ultrasmall grain, Anderson model (lattice with random on-site energy levels) and a 2-dimensional lattice, where the DOS has a van Hove singularity.

TT 20.22 Wed 14:00 Poster A

Correlation Functions in the Non-Equilibrium Anisotropic Kondo Model — •Peter Fritsch and Stefan Kehrein — Physics Department, ASC, and CeNS, Ludwig-Maximilians-Universität, Theresienstrasse 37, 80333 Munich, Germany

In this work we investigate the spin-spin correlation function in the Anisotropic Kondo Model using the method of infinitesimal unitary transformations (flow equations) [1]. We derive a perturbative scaling picture of the model which allows us to study the long-time evolution of observables. Within this framework we are able to study the effect of both equilibrium and non-equilibrium (dc voltage bias) decoherence on the physical properties of this model.

Future plans include the investigation of the Kondo Model in a magnetic field. This work is a generalization of the previous flow equation analysis of the non-equilibrium Kondo Model [2] for systems without SU(2)-symmetry.

[1] S. Kehrein, The Flow Equation Approach to Many-Particle Systems, Springer Tracts in Modern Physics 217

[2] S. Kehrein, Phys. Rev. Lett. 95, 056602 (2005)

TT 20.23 Wed 14:00 Poster A

High-Field NMR Relaxation Rates in Spin-1/2 Heisenberg-Chains — •Simon Grossjohann[1], Wolfram Brenig[1], Hannes Kühne[2], and Hans-Henning Klauss[2] — [1]Institut für Theoretische Physik, Technische Universität Braunschweig, D-31806 Braunschweig, Germany — [2]Institut für Physik der Kondensierten Materie, Technische Universität Braunschweig, D-38106 Braunschweig, Germany

We study the critical dynamics of the one-dimensional antiferromagnetic spin-1/2 Heisenberg chain across the field-driven quantum phase transition into the fully polarized state at saturation field. Using a Quantum-Monte-Carlo approach based on the the Stochastic Series Expansion we evaluate the low-temperature transverse and longitudinal imaginary-time spin-correlation functions and perform analytic continuation to the frequency domain by Maximum-Entropy methods. Results will be presented in the thermodynamic limit for the temperature T, magnetic-field B, and momentum dependence of the dynamic structure factor. In particular we analyze these results in terms of the transverse nuclear-magnetic relaxation time $T_1(T, B)$. We observe a clear signature of quantum critical slowing-down, leading to an enhanced relaxation in the vicinity of the saturation field as well as relaxation from gapful excitations only above criticality. Finally, we compare our calculations with recent high-field $1/T_1$ NMR-data as observed on CuPzN and find satisfying agreement for all temperatures and magnetic fields investigated.

TT 20.24 Wed 14:00 Poster A

Quantum Critical Spin Dynamics of a Cu(II) S=1/2 antiferromagnetic Heisenberg chain studied by ^{13}C-NMR spectroscopy — •H. Kühne[1], J. Litterst[1], H.-H. Klauss[1], S. Grossjohann[2], W. Brenig[2], A.P. Reyes[3], P.L. Kuhns[3], C.P. Landee[4], M.M. Turnbull[4], H.-J. Grafe[5], J. Haase[5], and B. Büchner[5] — [1]Institut für Physik der Kondensierten Materie, TU Braunschweig — [2]Institut für Theoretische Physik, TU Braunschweig — [3]NHMFL, FSU, Tallahassee, USA — [4]DPC, Clark University, Worcester, USA — [5]Leibnitz-Institut für Werkstoffforschung, Dresden

The antiferromagnetic S=1/2 Heisenberg chain is a model system for quantum many-body physics. It allows a direct comparison between exact theoretical results and experiment for ground state properties and excitations. $Cu(C_4H_4N_2)(NO_3)_2$ (CuPzN) is a very good experimental realization of an unperturbed S=1/2 chain [1,2]. In this compound we study the low energy spin dynamics of a Cu(II) S=1/2 spin chain system by means of NMR. We measured the nuclear spin-lattice relaxation rate of ^{13}C as a function of temperature in a wide external magnetic field range from 2T-22T, with an emphasis on the critical field range around 15T. The experimental data are in very good agreement with Quantum Monte Carlo calculations and clearly show the crossover from quantum critical behavior at low temperatures to diffusive modes at elevated temperatures.[1] P. Hammar et al., PRB. 59, 1008 (1999). [2] M.B. Stone et al., PRL 91, 037205 (2003).

TT 20.25 Wed 14:00 Poster A

Magnetic properties and evidence for lattice instabilities of the frustrated 2D s=1/2 systems (CuCl)$LaNb_2O_7$ and (CuBr)$LaNb_2O_7$. — •Patric Scheib[1], Vladimir Gnezdilov[2], Peter Lemmens[1], Yuri Georgii Pashkevich[3], Kazuyoshi Yoshimura[4], Yoshitami Ajiro[4], Taro Kitano[4], and Hiroshi Kageyama[4] — [1]Institut für Physik der kondensierten Materie, TU-Braunschweig, Braunschweig — [2]Institute for Low Temperature Physics and Engineering, NASU, Kharkov, Ukraine — [3]Donetsk Phystech, NASU, Ukraine — [4]Department of Chemistry, Kyoto University, Kyoto, Japan

We report on the magnetic properties and raman scattering data of the double-layered perovskites (CuBr)$LaNb_2O_7$ and (CuCl)$LaNb_2O_7$ with a square lattice of $s = \frac{1}{2}$ prepared by topotactic ion-exchange re-

actions. Evidence for competing ferro- and antiferromagnetic exchange pathes connecting nearest and second-nearest-neighbors, respectively, exist. Despite nearly identical structural parameters of the two compounds there is a different magnetic ground state. Work supported by DFG and ESF-HFM.

TT 20.26 Wed 14:00 Poster A

Bilayer antiferromagnet with four-spin interaction — •Thomas C. Lang[1] and Anders W. Sandvik[2] — [1]Institut für Theoretische Physik und Astrophysik, Universität Würzburg — [2]Department of Physics, Boston University

We investigate a spin-1/2 Heisenberg antiferromagnet with four-spin interaction on bilayer square and honeycomb lattices. In addition to the standard Neel and quantum disordered phases, these models can be expected to have a valence-bond-solid (VBS) phase. We locate the VBS phase and investigate, in particular, a transition from quantum disorder to VBS. This is potentially a deconfined quantum critical point. We use the recently introduced ground state projection Monte Carlo method in the valence bond basis which allows us to study these models without negative-sign problems.

TT 20.27 Wed 14:00 Poster A

Causes of weak-localization of electrons on liquid helium — •Jürgen Klier, Annie Wakata, and Paul Leiderer — Universität Konstanz, Fachbereich Physik, D-78457 Konstanz

Weak localization (WL) is a quantum effect caused by the coherence among multiple elastic-scattering paths of a conduction electron. This coherence leads to an enhanced backscattering probability and an increase in the resistivity over the classical Drude model. We have investigated the dephasing processes in a weak localization experiment of a two-dimensional electron system on liquid helium. From low-field magnetoconductivity measurements we can separate the damping of WL on the dephasing of electrons due to electron-electron interaction and the motion of the helium vapour atoms. We observe an intermediate regime where both damping mechanisms are of comparable importance and determine the transition from one dominant regime to the other. This is the first observation of a cross-over from the simple exponential decay to the cubic exponential damping in such a system.

TT 20.28 Wed 14:00 Poster A

Anion ordering transition in organic quantum spin chains $(TMTTF)_2X$ investigated by ESR and SQUID — •Shadi Yasin, Belal Salameh, Michael Dumm, and Martin Dressel — 1. Physikalisches Institut, Universität Stuttgart, Germany

The organic charge-transfer salts $(TMTTF)_2X$ are $S = 1/2$ quantum spin chains. The low temperature physical properties of these materials depend strongly on the size and shape of the counter-anion X. Species with non-centrosymmetric anions like ReO_4, BF_4, and SCN show an anion-order transition at 40 K $< T_{AO} <$ 160 K. This breaking of the inversion symmetry of the molecular conductors has strong impact on the spin and charge degrees of freedom. We investigated the nature of the anion-ordered ground state by temperature dependent ESR and SQUID experiments. We found that the temperature dependence of the ESR linewidth and the spin susceptibility changes drastically below T_{AO} in the compounds with $X = ReO_4$ and BF_4 where a spin gap Δ_σ opens in the non-magnetic anion-ordered ground state. Contrary, in $(TMTTF)_2SCN$ the ESR linewidth and the spin susceptibility show only a shallow change below T_{AO}. This is an indication that anion order is accompanied by charge order but not by spin order.

TT 20.29 Wed 14:00 Poster A

Low-temperature study of an $S = 1/2$ antferromagnetic Heisenberg chain close to the field-induced quantum critical point — •K. Remović-Langer[1], Y. Tsui[1], U. Tutsch[1], V. Pashchenko[1], B. Wolf[1], A. V. Prokofiev[2], and M. Lang[1] — [1]Physikalisches Institut, J. W. Goethe-Universität, Frankfurt(M), Germany — [2]Institut für Festkörperphysik, Technische Universität Wien, Wien, Austria

We present magnetic susceptibility, electron spin resonance (ESR), and magnetocaloric effect (MCE) measurements of the compound $[Cu(\mu\text{-ox})(4\text{-apy})_2(H_2O)]_n$ [1]. Magnetic susceptibility measurements, performed in the temperature range from 50 mK up to 300 K, can be interpreted within an uniform 1D Heisenberg model with a small antiferromagnetic exchange interaction of $J/k_B \approx (3.14 \pm 0.1)$K. The magnetization $M(B)$ was obtained by integrating the susceptibility data. At the lowest temperatures, $M(B)$ saturates at a field $\mu_0 H_{sat} = (4.3 \pm 0.1)$ T. The angular dependence of the resonance absorption line, obtained from ESR measurements, reveals the magnetic anisotropy of the $S = 1/2$ copper ions. MCE measurements were performed at low temperatures and at fields in the vicinity of the saturation field which, at zero-temperature, marks a quantum phase transition with intriguing magnetocaloric properties[2]. The significance of the MCE results will be discussed.

[1]A. V. Prokofiev et. al. , submitted to Crystal Research and Technology. [2]L. Zhu et. al., Phys. Rev. Lett. **91**, 066404 (2003); M. E. Zhitomirsky, A. Honecker, J. Stat. Mech.: Theor. Exp (2004) P07012.

TT 20.30 Wed 14:00 Poster A

^{7}Li NMR and ESR study of the Cu spin dynamics and Li mobility in the frustrated spin-1/2 chain cuprate Li_2ZrCuO_4 — •Y. Arango[1], E. Vavilova[1,2], V. Kataev[1,2], S.-L. Drechsler[1], A. Moskvin[3], O. Volkova[1,4], A. Vasilyev[4], and B. Büchner[1] — [1]Institute for Solid State and Materials Research IFW Dresden, D-01171 Dresden, Germany — [2]Kazan Physical Technical Institute of RAS, 420029 Kazan, Russia — [3]Ural State University, 620083 Ekaterinburg, Russia — [4]Moscow State University, 119992 Moscow, Russia

The new frustrated quasi-1D quantum spin system Li_2ZrCuO_4 is close to a ferromagnetic critical point and exhibits unusual thermodynamic properties. The crystal structure of Li_2ZrCuO_4 contains CuO_2 chains and two different types of Li positions. The first type is regularly occupied. The second type is 50 % occupied. Thus, there are two equivalent positions for type II between which the Li ions can hop. We have measured Cu^{2+} ESR and ^{7}Li NMR in Li_2ZrCuO_4. The ESR data reveal a strong enhancement of quasi-static spin correlations below $\sim 50-60$ K and possibly a transition to a magnetically ordered state below ~ 8 K. The ^{7}Li NMR spectrum consists of two lines which can be assigned to the two nonequivalent Li positions. The analysis of the spectral shape and relaxation times T_1 and T_2 strongly corroborates the ESR results regarding the slowing down of the Cu spin dynamics and gives a clear indication of the magnetric order at low T. Moreover, the NMR monitors the mobility of the Li ions in Li_2ZrCuO_4 and yields a characteristic temperature $T_g \sim 80$ K for the quenching of the hopping of the Li ions between the two type II-positions.

TT 20.31 Wed 14:00 Poster A

In_2VO_5 - a new low dimensional S = 1/2 system probed by magnetic resonance — •M. Yehia[1], E. Vavilova[1], T. Taetz[2], A. Möller[2], V. Kataev[1], B. Büchner[1], N. Hollmann[3], and J.A. Mydosh[3] — [1]Institute for Solid State and Materials Research IFW Dresden, D-01171 Dresden, Germany — [2]Institut für Anorganische Chemie, Universität zu Köln, 50939 Köln, Germany — [3]II. Physikalisches Institut, Universität zu Köln, 50937 Köln, Germany

In_2VO_5 contains paramagnetic V^{4+} ($3d^1$, $S = 1/2$) ions. The structural feature is a double chain of VO_6-polyhedra along the b-axis. X-ray diffraction reveals a change of the lattice contraction from isotropic at high T to anisotropic below 150 K. In the spin sector this leads to a change in the spin topology from coupled $S = 1/2$ chains to coupled $S = 1/2$ triangles along the b-axis. ESR and ^{51}V NMR data give evidence that the structural changes have a strong impact on the magnetic properties. The static susceptibility suggests a transition from ferromagnetic exchange above a characteristic temperature $T^* \sim 120$ K to antiferromagnetic (AF) exchange at $T < T^*$. ESR and NMR reveal a slowing of the d-electron spin dynamics as a consequence of enhanced AF correlations at $T < T^*$ and an AF ordering at $\sim$20 K. Remarkably, a well defined ESR signal from V^{4+} ions can only be observed below T^*, strongly suggesting the localization of the d-states. Indeed, the resistivity data, $\rho(T)$, show a dramatic increase of ρ and a transition to an insulating behaviour at $T < T^*$. We discuss these experimental observations in terms of a significant interplay between structure, magnetism and charge mobility in this novel material.

TT 20.32 Wed 14:00 Poster A

Magnetic heat conduction in Ca-doped $SrCuO_2$ spin chains and related systems — Patrick Ribeiro, •Nikolai Hlubek, Anja Waske, Christian Hess, and Bernd Büchner — IFW-Dresden, Helmholzstr.20, 01069 Dresden, Germany

We present new results on the heat conduction of the spin-chain system $Sr_{1-x}Ca_xCuO_2$. The structure of this material contains two parallel antiferromagnetic $S = 1/2$ copper chains with a $J_{||} \approx 2100K$. They are decoupled from each other due to a frustration arising from the displacement of half a Cu-Cu length between them. Additionally to the regular phonon heat conduction, this material possesses spinon

contributions in the chain direction. A separation of both contributions is ambiguous, since the spinon contribution appears in form of a hump on the low-temperature phonon peak. By substituting the Sr by the isovalent Ca, we aim at a separation of both contributions. The smaller Ca leads to an increased scattering of phonons and consequently to the suppression of the phonon heat conductivity. Since strong changes of the magnetic properties by this doping are unlikely, we expect the spinon contributions to remain untouched. However, a reduction of the spinon contribution is observed upon doping. To explain this observation two scenarios are considered: on the one hand the spin-phonon-drag effect, on the other a possible Ca-induced modulation of the coupling constant due to the doping, that would lead to spinon scattering. Comparisons with earlier results on similar systems, such as the spin ladder $Sr_{14}Cu_{24}O_{41}$ and the buckled pseudo-two-leg spin ladder $CaCu_2O_3$, are carried out.

TT 20.33 Wed 14:00 Poster A

Electrochemical doping of Vanadium Oxide Nanotubes — •A. Popa[1], I. Hellmann[1], R. Klingeler[1], V. Kataev[1], E. Vavilova[1,2], Y. Arango[1], C. Täschner[1], X. Liu[1], M. Knupfer[1], C. Masquelier[3], and B. Büchner[1] — [1]Leibniz-Institute for Solid State and Materials Research IFW Dresden, Dresden, Germany — [2]Kazan Physical Technical Institute, RAS, Kazan, Russia — [3]Laboratoire de Réactivité et de Chimie des Solides, Amiens, France

Vanadium oxide nanotubes (VOx-NTs) exhibit diverse properties ranging from spin frustration and semiconductivity to ferromagnetism by doping with either electrons or holes [1]. We have applied optical, photoemission and EELS as well as static magnetization, ESR and NMR studies in order to obtain insight into the rich physics of these materials. Our data suggest an averaged vanadium valency of about 4.4+ in the undoped case [2]. We observe two magnetically nonequivalent vanadium sites, attributed to V^{4+} ions ($3d^1, S = 1/2$) in octahedral and tetrahedral oxygen coordination and there are strong indications that antiferromagnetic dimers and trimers occur in the vanadium-spin chains in the walls. We find a spin gap of the order of 700 K [3]. Upon electron doping of VOx-NTs, our spectroscopic data confirm a higher number of magnetic V^{4+} sites. Besides, the magnetic response was studied after the electrochemical insertion of lithium. For certain doping levels, a ferromagnetic signal at room temperature was found.

[1] L. Krusin-Elbaum *et al.*, Nature **431**, 672 (2004)
[2] X. Liu *et al.*, Phys. Rev. B **72**, 115407 (2005)
[3] E. Vavilova *et al.*, Phys Rev. B **73**, 144417 (2006)

TT 20.34 Wed 14:00 Poster A

Magnetic exchange interactions in 1D and 2D cuprates — Ulrike Nitzsche[1], Stefan-Ludwig Drechsler[1], and •Helge Rosner[2] — [1]IFW Dresden — [2]MPI CPfS Dresden

In many copper oxygen networks, especially for Cu-O bond angles close to 90°, ferromagnetic (FM) interactions play an important role in addition to the well known superexchange $J \sim t^2/U$. We present a systematic study of the electronic structure and the exchange integrals J for different types of 1D and 2D spin 1/2 cuprates: edge shared (Li_2CuO_2) and corner shared (A_2CuO_3 [A=Sr,Ca]) single-chains, double-chains ($SrCuO_2$), and planar ($CaCuO_2$, $Sr_2CuO_2Cl_2$, R_2CuO_4 [R=La,Nd,Sm]) arrangements. Based on full potential LDA and LDA+U band structure calculations and subsequent tight-binding (TB) models we estimate sign and magnitude of the most relevant J's. We compare the results of total energy calculations with those of TB models from one-band and multi-band approaches. The FM contributions can be estimated from the difference between the TB and the total energy results. We investigate the effect of the inter-plaquette geometry (edge shared vs. corner shared CuO_2 plaquettes) and the intra-plaquette geometry under pressure on the coupling strength. In excellent agreement with various experiments, our calculations result in: (i) dominant FM nearest neighbor (NN) coupling $J_1 \sim$ -17 meV in Li_2CuO_2, (ii) strongly enhanced AFM NN $J_1 \sim$ 180 meV for the 1D corner shared chains compared to (iii) $J_1 \sim$ 110...150 meV for the 2D compounds where we observe a sequence of J's (with respect to the cations) in agreement with the experimental data.

TT 20.35 Wed 14:00 Poster A

Anisotropy of superconducting critical fields of α-(BEDT-TTF)$_2$KHg(SCN)$_4$ under pressure — •Sebastian Jakob, Karl Neumaier, Werner Biberacher, and Mark Kartsovnik — Walther-Meissner-Institut, Garching, Germany

Our previous studies of the "magnetic field - pressure - temperature"phase diagram of the layered organic conductor α-(BEDT-TTF)$_2$KHg(SCN)$_4$ have revealed an interesting interplay between a charge density wave (CDW) and a superconducting (SC) state [1]. At a critical pressure of 2.5 kbar the CDW state is completely suppressed and a sharp transition into a SC state is observed below 100 mK. For pressures below 2.5 kbar there is a coexistence of the superconducting and CDW state, but this is likely a spatially inhomogenous state. The neighbouring of a CDW and SC state is an interesting situation and rises questions about the nature of the superconductivity. We have therefore investigated the anisotropy of the critical fields at a pressure slightly above the critical one. The experiments were performed in a dilution refrigerator down to 25 mK. Two-axes rotation of the magnetic field allowed the exact determination of the anisotropy parallel and perpendicular to the layers, but also the inplane anisotropy.

[1] D. Andres, M. V. Kartsovnik, W. Biberacher, K. Neumaier, E. Schuberth, H. Müller, Phys. Rev. **B 72**, 174513 (2005).

TT 20.36 Wed 14:00 Poster A

ESR investigations of the phase diagram of 2-dim organic conductors in the vicinity of the Mott-Hubbard transition — •Shadi Yasin, Michael Dumm, and Martin Dressel — 1. Physikalisches Institut, Universität Stuttgart, 70550 Stuttgart, Germany

In the two-dimensional layered organic charge-transfer salts κ-(BEDT-TTF)$_2$Cu[N(CN)$_2$]Br$_x$Cl$_{1-x}$, it is possible to tune the electronic and magnetic properties by bandwidth control, i. e., by a systematic variation of the external or chemical pressure (anion size) as presented here. While the materials with low Br content x are antiferromagnetic insulators at low temperatures, the materials with high Br concentration show superconductivity. We studied the phase diagram in the vicinity of the Mott-Hubbard transition as a function of Br content by electron-spin resonance in the temperature range 4.2 K $< T <$ 295 K along all three crystal axes. A detailed analysis of the ESR linewidth, the spin susceptibility and the microwave conductivity which was derived from the asymmetric Dysonian shape of the absorption lines was performed. These results enabled us to map the critical temperatures of the metal-to-insulator, antiferromagnetic and superconducting transitions for different Br dopings. We will also discuss the unconventional behaviour of ESR linewidth and spin susceptibility at temperatures below 50 K where the properties of the materials are dominated by strong electronic correlations.

TT 20.37 Wed 14:00 Poster A

Probing the metal-insulator transition in $\kappa-(ET)_2Cu_2(CN)_3$ by hydrostatic He-gas pressure experiments — Christian Strack[1], Michael Lang[1], and •John Schlueter[2] — [1]Physikalisches Institut, J.W.-Goethe-Universität, Frankfurt/Main, FOR 412 — [2]Materials Science Division, Argonne NL, Illinois, USA

The title compound has gained considerable interest from both the theoretical and experimental side, see e.g. [1+2]. It is a Mott-insulator characterized by a triangular lattice with almost perfect magnetic frustration. This leads to the absence of long-range magnetic ordering down to 32 mK, the lowest temperature investigated so far [3]. The system, therefore, is a promising candidate for a quantum spin liquid without symmetry breaking [4], which contrasts with the $\kappa-(ET)2Cu[N(CN)2]Cl$ salts, where a less strong frustration gives rise to long-range magnetic order of local moments. Both systems become metallic and superconducting under pressure with a similar resistivity profile. Comparative studies of the pressure-induced insulator to metal transition for both compounds thus provide a deep insight into the nature of the correlated electron system and, specifically, the role of magnetism. Using both temperature-dependent resistivity measurements under pressure and pressure sweeps at constant temperatures, the phase diagram of the title compound has been explored. A detailed study of the transition from insulator to metal will be presented.

[1] S. Lee et al. PRL 95, 036403 (2005) [2] E. Ohmichi et al. PRB, Vol. 57, No. 13 [3] Y. Shimizu et al. PRL, Vol. 91,No. 10 (2003) [4] Y. Kurosaki et al. PRB, 95,177001 (2005)

TT 20.38 Wed 14:00 Poster A

Spin liquid ground state in the frustrated $S = 1/2$ square lattice compound $PbVO_3$ — Alexander Tsirlin[1,2], Roman Shpanchenko[2], Evgeny Antipov[2], Alexei Belik[3], Eiji Takayama-Muromachi[3], and •Helge Rosner[1] — [1]MPI CPfS, Dresden, Germany — [2]Department of Chemistry, MSU, Russia — [3]NIMS, Tsukuba, Japan

The $S = 1/2$ square lattice is known to be one of the simplest models of low-dimensional spin systems depicting the magnetic properties of many transition metal compounds like La_2CuO_4. If one consid-

ers nearest-neighbor (NN) interactions only, long-range spin order is established in the square lattice. Nevertheless, taking into account next-nearest neighbor (NNN) interactions may result in strong frustration of the spin system and give rise to unusual collinear magnetic order or spin liquid ground states. Here, we present a joint experimental and computational study of a novel layered vanadium oxide $PbVO_3$ realizing a square lattice of magnetic V^{+4} atoms. Our results show that in $PbVO_3$ antiferromagnetic NN (J_1) as well as NNN (J_2) interactions are present. The J_2/J_1 ratio is about 0.3 corresponding to a boundary between AFM ordered and spin liquid ground states. This conclusion is in a perfect agreement with magnetic susceptibility and specific heat measurements showing no sign of long-range spin order down to 2 K. $PbVO_3$ is likely to be the first system showing spin liquid ground state for the frustrated $S = 1/2$ square lattice.
The Alfred Toepfer Foundation and the Emmy-Noether program are acknowledged for financial support.

TT 20.39 Wed 14:00 Poster A

Initial stages of growth of the strongly correlated Fe_3O_4 thin films — •Stefan Klein[1], Chun Fu Chang[1], Zhiwei Hu[1], Philipp Hansmann[1], Hong-Ji Lin[2], Chien-Te Chen[2], and Liu Hao Tjeng[1] — [1]II. Physikalisches Institut, Universität zu Köln, Zülpicher Str. 77, 50937 Köln — [2]National Synchrotron Radiation Research Center,101 Hsin-Ann Road, Hsinchu 30076, Taiwan

We have investigated the initial stages of growth of the polar $Fe_3O_4(001)$ thin films using reflection high-energy electron diffraction, low-energy electron diffraction and soft X-ray absorption spectroscopy (XAS). A series of epitaxial thin films with varying thicknesses were grown by molecular-beam epitaxy in O_2 atmosphere on MgO(001) substrates. From the analysis of the XAS spectra, we established a model for the growth process. Furthermore, the surface reconstruction of $Fe_3O_4(001)$ will also be discussed. Supported by the DFG through SFB 608.

TT 20.40 Wed 14:00 Poster A

X-ray absorption and photoemission study of spin state and metal-insulator transition in$GdBaCo_2O_{5.47}$ — •Z. Hu[1], Hua Wu[1], T. Koethe[1], M. W. Haverkort[1], T. Burnus[1], J. Gegner[1], C. Zobel[1], T. Lorenz[1], S. N. Barilo[2], H.-J. Lin[3], N. B. Brookes[4], C. T. Chen[3], and L. H. Tjeng[1] — [1]II. Physikalisches Institut,Universität zu Köln, Zülpicher Straße 77, 50937 Köln — [2]Institute of Solid State and SemiconductorsPhysics, National Academy of Sciences, Belarus — [3]National Synchrotron RadiationResearch Center, Taiwan — [4]European Synchrotron Radiation Facility, France

The fundamental physics of the magnetoresistance materials $RBaCo_2O_{5.5}$ (R =Sm, Eu, Gd, Tb, Dy, Y), particularly the issue of spin-state and metal-insulator transition (MIT), is currently under intense debate. Using valence-band photoemission spectra and x-ray absorption spectra at both the O-K and Co-$L_{2,3}$ edges, we found that crossing the MIT, the band gap decreases but does not collapse across the MIT. More significantly, our spectroscopic evidence firmly rules out the widely accepted model for the low-temperate phase, namely that the Co^{3+} ions in the octahedral sites are mainly low spin and in the pyramidal sites intermediate spin. We rather found that the MIT in this system is very similar to the high temperature (600 K) MIT of $LaCoO_3$.

TT 20.41 Wed 14:00 Poster A

Spectral line shapes in soft x-ray diffraction — •C. Schüssler-Langeheine, J. Schlappa, M. W. Haverkort, and L. H. Tjeng — II. Physikalisches Institut, Universität zu Köln

Resonant diffraction in the soft x-ray range is a powerful spectroscopic method to study order phenomena like charge, spin and orbital order as they are found in correlated electron systems. In particular this technique is capable to differentiate between true modulations of the electronic states and pure modulations of the lattice like strain waves. For energetically sharp resonances like the $L_{2,3}$ thresholds of transition metals, the spectral shape of the diffraction spectrum differs significantly between a predominantly structural and a predominantly electronic superstructure. This difference is caused by the interference of resonant and non-resonant scattering, which acts differently in the two cases and can be used as a qualitative fingerprint of the two scenarios. Supported by the DFG through SFB 608.

TT 20.42 Wed 14:00 Poster A

Coulomb correlations in Cu_2O and ZnO: Importance of both transition-metal U_{dd} and Oxygen U_{pp} — •Sven Binder, Hua Wu, Thomas Koethe, Stefan Klein, and Liu Hao Tjeng — II. Physikalisches Institut, Universität zu Köln, Zülpicher Straße 77, 50937 Köln

Standard local density approximation (LDA) band structure calculations for Cu_2O and ZnO produce valence band spectra which show significant deviations from the experimentally observed spectra as obtained from photoemission. This is surprising since one may assume that Coulomb interactions can be well taken into account in a mean-field manner for closed shell systems. In an attempt to resolve this issue, we have performed LDA+U calculations. We have discovered that not only we have to include the Coulomb interaction in the 3d shell (U_{dd}) but also in the O 2p shell (U_{pp}). To justify this approach, we have set out to determine experimentally the values for U_{dd} and U_{pp} by performing L_3VV and KLL Auger spectroscopies for Cu_2O and ZnO.

TT 20.43 Wed 14:00 Poster A

Magnetic and electrical properties of EuC_2 — •Oliver Heyer[1], Derk Wandner[2], Nils Hollmann[1], Uwe Ruschewitz[2], John Mydosh[1], Axel Freimuth[1], and Thomas Lorenz[1] — [1]II. Physikalisches Institut, Universität zu Köln, D-50937 Köln — [2]Institut für Anorganische Chemie, Universität zu Köln, D-50939 Köln

We present measurements of the magnetization M, the specific heat c_p and the resistance ρ of EuC_2.This compound is interesting because Eu exists in the oxidation states +2 as well as +3. Thus EuC_2 may be located between the pure ionic carbides of the divalent alkaline earth (CaC_2, SrC_2) and the metallic carbides of the trivalent lanthanides (LaC_2, CeC_2). Possibly, one may even change the valency under pressure or temperature variation. The magnetization and the specific heat data indicate a ferromagnetic ordering at $T_c \sim 12$ K. According to a very small hysteresis EuC_2 may be classified as a soft ferromagnet. Above T_c the resistance shows a semiconducting behaviour. With the onset of the magnetic order the resistance decreases over 4 orders of magnitude indicating a metal-insulator transition (MIT). Moreover, an applied magnetic field shifts the MIT temperature to higher values, resulting in a colossal magnetoresistance with changes in the resistivity up to 6 orders of magnitude. This behaviour strongly resembles the colossal magnetoresistance of the better-known system of Eu-rich EuO.

TT 20.44 Wed 14:00 Poster A

Crystal growth, dielectric and magnetic investigation of 3d transition metal tungstates MWO_4 (M = Mn, Fe, Co, Ni) — •Sven Jodlauk[1], Daniel Khomskii[2], Petra Becker[1], Ladislav Bohatý[1], Oliver Heyer[2], Nils Hollmann[2], Harald Kierspel[2], Thomas Lorenz[2], and John Mydosh[2] — [1]Institut für Kristallographie, Universität zu Köln — [2]II. Physikalisches Institut, Universität zu Köln

Some tungstates MWO_4 seem to be promising candidates for multiferroics whose dielectric properties are caused by a spiral spin ordering. Single-crystal growth of 3d transition metal tungstates MWO_4 (M = Mn, Fe, Co, Ni) can either be done using the flux technique and an adapted melt solvent from the system Na_2WO_4 - WO_3 (basing on early work of Schultze et al. [1]) or, especially in the case of $MnWO_4$, from high-temperature melt. This latter method is able to prevent Mn^{2+} from oxidation. Single crystals of $MnWO_4$ obtained from our crystal growth are of ruby-red color and of dimensions up to 25 * 5 * 4 mm^3. Temperature dependent dielectric and pyroelectric measurements on $MnWO_4$ (using a (010) plate) reveal anomalies which correlate with the anomalies that were detected for temperature dependent magnetic susceptibility. This signals that $MnWO_4$ is a magneto-electric multiferroic. Results of this work have been published in [2].

References

[1] D. Schultze, K.-Th. Wilke, Ch. Waligora: Z. anorg. allg. Chemie **352** (1967) 184-191. [2] O. Heyer *et al.*: J. Phys.: Condens. Matter **18** (2006) L471-L475.

TT 20.45 Wed 14:00 Poster A

Structural and magnetic dimers in the spin-gapped system $CuTe_2O_5$ — •Hans-Albrecht Krug von Nidda[1], Joachim Deisenhofer[2], Rushana Eremina[1,3], Tatiana Gavrilova[3], Mike Whangbo[4], and Alois Loidl[1] — [1]Experimental Physics V, Electronic Correlations and Magnetism, University of Augsburg, 86135 Augsburg, Germany — [2]Département de Physique de la Matière Condensée, Université de Genève, CH-1211 Genève 4, Switzerland — [3]E. K. Zavoisky Physical-Technical Institute, 420029 Kazan, Russia — [4]Department of Chemistry, North Carolina State University, Raleigh, North Carolina

27695-8204, USA

We investigate the magnetic properties of the system $CuTe_2O_5$ by susceptibility and electron spin resonance ESR measurements. The anisotropy of the effective g-factors and the ESR linewidth indicates that the anticipated structural dimer does not correspond to the singlet-forming magnetic dimer. Moreover, the spin susceptibility of $CuTe_2O_5$ can only be described by taking into account interdimer interactions of the same order of magnitude than the intradimer coupling. Analyzing the exchange couplings in the system we identify the strongest magnetic coupling between two Cu ions to be mediated by a super-superexchange interaction via a bridging Te ligand, while the superexchange coupling between the Cu ions of the structural dimer only results in the second strongest coupling.

TT 20.46 Wed 14:00 Poster A

Electric transport properties of $LaAlO_3/SrTiO_3$ interfaces studied by scanning electron microscopy — •Christian Gürlich[1], Matthias Ruoff[1], Stefan Thiel[2], Christof Schneider[2], German Hammerl[2], Christoph Richter[2], Jochen Mannhart[2], Reinhold Kleiner[1], and Dieter Koelle[1] — [1]Physikalisches Institut, Experimentalphysik II, Universität Tübingen, Auf der Morgenstelle 14, D-72076 Tübingen, Germany — [2]Center for Electronic Correlations and Mangnetism, Institut of Physics, Augsburg University, D-86135 Augsburg, Germany

It was shown recently that conducting electron gases are formed at interfaces in heterostructures consisting of insulating oxides such as $SrTiO_3/LaTiO_3$ (STO/LTO) or $LaAlO_3/SrTiO_3$ (LAO/STO) [1]. These conducting electron gases might be confined to sheets that are only very few nanometers thick. Lateral confinement into a bridge-like structure has been realized for STO/LAO interfaces, using lithographic patterning by modulating the thickness of the LAO layers with unit cell resolution [2]. Here, we present a scanning electron microscopy study of the electric transport properties of such structures. Irradiation with a focused electron beam induces pronounced changes of the sample resistance, with a typical reduction by more than a factor of two at 300 K. After switching off the electron beam, the resistance returns to the initial state with relaxation times above several hundred seconds.

[1] H. Y. Hwang, Science vol. 313, 1895 (2006) and references therein.
[2] C. W. Schneider *et al.*, Appl. Phys. Lett. vol. 89, 122101 (2006).

TT 20.47 Wed 14:00 Poster A

Unoccupied electronic structure of TiOCl studied by XAS — •Sebastian Glawion[1], Götz Berner[1], Matthias Schlachter[1], Michael Sing[1], Markus Hoinkis[2], Gianina Gavrila[3], Leonardo Pisani[4], Roser Valenti[4], and Ralph Claessen[1] — [1]Experimentelle Physik 4 and Röntgen Research Center for Complex Materials, Universität Würzburg, D-97074 Würzburg, Germany — [2]Experimentalphysik II, Universität Augsburg, D-86135 Augsburg, Germany — [3]Institut für Physik, Technische Universität Chemnitz, D-09107 Chemnitz, Germany — [4]Institut für Theoretische Physik, Universität Frankfurt, D-60054 Frankfurt, Germany

TiOCl is a Mott-insulating quantum magnet showing a dimerized spin-Peierls phase for temperatures below T_c1=67K. This phase is reached through two distinct phase transitions. The intermediate phase shows incommensurate order, while the susceptibility of the high-T phase nicely reflects the behaviour of a 1D Heisenberg antiferromagnet. Intensive studies in this latter phase have been conducted on the occupied density of states in the valence band both by (AR)PES and various calculations. However, since the low-T phase cannot be reached by PES due to charging problems, we conducted X-ray absorption studies searching for possible changes in the electronic structure induced by the different kinds of ordering. Our results nicely agree with previous LDA+U and GGA+U calculations but do not seem to show major differences between the different phases.

TT 20.48 Wed 14:00 Poster A

Electronic Raman scattering and phonon anomalies in Na_xCoO_2. — Vladimir Gnezdilov[1], Patric Scheib[2], •Peter Lemmens[2], Fangcheng Chou[4], Lambert Alff[5], Yoshiharu Krockenberger[3], Hanns-Ulrich Habermeier[3], Chengtian Lin[3], and Bernhard Keimer[3] — [1]Institute for Low Temperature Physics and Engineering, NASU, Kharkov, Ukraine — [2]Institut für Physik der kondensierten Materie, TU Braunschweig, Braunschweig — [3]Max-Planck-Institute for Solid State Research, Stuttgart — [4]Center for Materials Science and Engineering, MIT, Cambridge, USA — [5]Institute of Material Science, TU Darmstadt, Darmstadt

Raman scattering in nonsuperconducting and superconducting cobaltates $Na_xCoO_2 \cdot yH_2O$ shows pronounced anomalies in the phonon as well as the electronic contribution to the scattering cross section. The effect of doping and hydration on these anomalies is studied and used for a characterization of single crystals and thin films. Work supported by DFG, ESF-HFM and MRSEC Program of NSF under award number DMR 02-13282.

TT 20.49 Wed 14:00 Poster A

Low-Temperature Antiferromagnetic Phase Transition in α-YbPdSn — •Tobias Görlach[1], Sergiy Putselyk[1], Andreas Hamann[1], Tihomir Tomanic[1], Falko Schappacher[2], Rainer Pöttgen[2], and Hilbert v. Löhneysen[1,3] — [1]Physikalisches Institut, Universität Karlsruhe, D-76128 Karlsruhe, Germany — [2]Institut für Anorganische und Analytische Chemie, Westfälische Wilhelms-Universität Münster, Corrensstr. 30, D-48149 Münster, Germany — [3]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, D-76021 Karlsruhe, Germany

Ternary intermetallic compounds of the type YbTX where T is a transition metal and X is a main group metal, show a wide variety of magnetic properties at low temperatures [1]. More specifically, stannides (X = Sn) show different types of magnetic order. While YbNiSn orders ferromagnetically at T_C = 5.6 K, YbRhSn and YbPtSn order antiferromagnetically at 1.85 K and 3.5 K, respectively, YbPtSn also being metamagnetic. Here we present evidence for magnetic order at very low temperatures in YbPdSn, whose magnetic properties have previously been investigated at temperatures above 4.2 K only. Our low-temperature measurements of the specific heat and the magnetic susceptibility indicate an antiferromagnetic phase transition at 200 mK which is suppressed rapidly in moderate magnetic fields.

[1] R. Pöttgen, D. Johrendt and D. Kußmann, in: *Handbook of the Physics and Chemistry of the Rare Earths* (Elsevier Science B.V., Amsterdam, 2001), vol. **32**, ch. 207, pp. 455–515.

TT 20.50 Wed 14:00 Poster A

Thermal expansion and specific heat of magnetically frustrated $(Ni_{1-x}Co_x)_3V_2O_8$ — •Qin Zhang[1], William Knafo[1,2], Kai Grube[1], Hilbert v. Löhneysen[1,2], Christoph Meingast[1], and Thomas Wolf[1] — [1]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, D-76021 Karlsruhe, Germany — [2]Physikalisches Institut, Universität Karlsruhe, D-76128 Karlsruhe, Germany

$Ni_3V_2O_8$ and $Co_3V_2O_8$ both have the same basic kagome-staircase structure, leading to geometric frustration of the magnetic ordering of the spins on Ni and Co sites. Both compounds exhibit a number of magnetic phase transitions at low temperatures, which partially relieve the frustration. In addition to magnetic ordering, these compounds also exhibit ferroelectric properties. Here we present thermal expansion and specific heat data on high-quality single crystals of $(Ni_{1-x}Co_x)_3V_2O_8$, which allow us to map out the phase diagram of the Ni-Co series, as well as to calculate various pressure derivatives associated with magnetic ordering.

TT 20.51 Wed 14:00 Poster A

Magnetisation of ferromagnetic Pr_5Si_3 under hydrostatic pressure — •Stefan Legl[1], Christian Pfleiderer[1], Dmitri Souptel[2], and Günter Behr[2] — [1]Physik Department E21, Technische Universität München, D-85748 Garching, Germany — [2]IFW Dresden, PF 270116, D-01171 Dresden, Germany

We report the low temperature magnetisation, specific heat and resistivity of single crystal Pr_5Si_3 at ambient pressure under magnetic field up to 9T and temperatures down to 3K.

Pr_5Si_3 orders ferromagnetically below T_c=50K. The ferromagnetic state is strongly anisotropic where the basal plane in the hexagonal crystal structure is the easy magnetic plane.

Under hydrostatic pressures up to 18 kbar the magnetisation for temperatures down to 3K and magnetic fields up to 9T shows only a weak variation of the ordered moment and T_c. Magnetisation loops at low magnetic fields show changes characteristic of the emergence of a magnetic modulation under pressure.

TT 20.52 Wed 14:00 Poster A

Transport and Ordering of Polarons in PrCaMnO: Electric induced Colossal Resistance Effect — •Sebastian Schramm, Peter Moschkau, Jörg Hoffmann, and Christian Jooss — Institut für Materialphysik, Universität Göttingen

The resistivity of the low-bandwidth manganite $Pr_{1-x}Ca_xMnO_3$ (x =

0.3 and x = 0.5) is affected by electric fields and currents. This Colossal Electroresistance (CER) includes a continuous lowering of the resistivity for high temperatures with increasing current and a sharp resistivity-drop at the characteristic temperature T_c for high currents. In thin films of PrCaMnO prepared by Pulsed Laser Deposition on $SrTiO_3$-substrates the resistivity in a wide temperature range can be described by a model, where thermally activated polarons (TAP) are the effective charge carriers. In a detailed series the resistivity especially of annealed samples shows a good agreement with the TAP-model. The change of resistivity in the PrCaMnO-films is a current-induced effect, strong Joule heating occurs as a secondary effect due to inherent nonlinearities in the current-voltage-characteristics. The resistivity-drop is accompanied by the destruction of a polaron-ordered phase and by a related structural modification of the lattice. The starting point of this dynamical disordering process is defined by a temperature dependent critical current and a critical electric field.

TT 20.53 Wed 14:00 Poster A

Development of an array of calorimetric low temperature detectors for heavy ions — •A. Echler[1,2], V. Adrianov[1,2], A. Bleile[1,2], P. Egelhof[1,2], S. Ilieva[1,2], O. Kiselev[1], S. Kraft-Bermuth[1,2], and J. P. Meier[1,2] — [1]Gesellschaft für Schwerionenforschung, Darmstadt, Germany — [2]Johannes Gutenberg Universität Mainz, Germany

Calorimetric low temperature detectors (CLTDs) for heavy-ion detection have been frequently demonstrated to achieve an excellent relative energy resolution of $\Delta E/E$ = 1-5×10^{-3} in a wide range of ions and energies. Such detectors were already successfully applied in accelerator mass spectrometry, and have the potential to be applied in superheavy element research where CLTDs as high resolution energy detectors combined with time-of-flight detectors may be used for identification of superheavy nuclei with Z ≥ 113. The CLTDs developed up to now have an active area of approximately 3×3 mm^2, not sufficient to fully exploit their potential. To increase the active area, an array of CLTDs for heavy ion research is currently subject of design and investigation. As a first step, a 4×2 pixel prototype array with eight individually temperature controlled pixels and a total active area of 12×6 mm^2 was realized and its performance under heavy ion irradiation was investigated. Results from a recent experiment performed with 4.8 MeV/u ^{132}Xe-ions will be presented, and future perspectives will be discussed.

TT 20.54 Wed 14:00 Poster A

Orbital responses in $3d^1$ perovskite titanates — •Luis Craco — Max-Planck Institute for Chemical Physics of Solids, Noethnitzer Str. 40, D-01187 Dresden, Germany

$LaTiO_3$ and $YTiO_3$ have long been considered as classic examples of systems where the change of electron correlations originates form a change in the 3d electron hopping, which is governed by the Ti-O bond angles. Using a combination of ab initio and correlated many-body treatments, we consider the role of lattice distortions and multi-orbital electron interactions in these classical $3d^1$ perovskites. We show how the Mott-Hubbard insulating state is affected by structural distortions and the concomitant orbital polarization pattern. For this we use the LDA+DMFT method, which combines the real one-electron band structure with dynamical effects of strong, electron interactions. Our band-structure results are consistent with a removal of the t_{2g} and e_g orbital degeneracy due to orthorhombic distortions. In this real band-structure, we show that the Mott insulating state is driven by strong electron interactions. The obtained correlated spectra shows good agreement with experiments (photo-emission and/or optics). We find that $La(Y)TiO_3$ are described as orbitally non-degenerate systems, where multi-orbital correlations, orbital polarization and disorder are very important in determining the nature of the paramagnetic insulating state. As an extension of our work, we plan to describe the (ferromagnetic) ground-state properties of $YTiO_3$ and the effect of pressure in the system.

TT 20.55 Wed 14:00 Poster A

Embedding procedure for ab-initio correlation calculations in group II metals — Elena Voloshina, Nicola Gaston, and •Beate Paulus — MPI fuer Physik komplexer Systeme, Noethnitzer Str. 38, 01187 Dresden, Germany

Up to now wavefunction-based ab-initio correlation treatements are possible for semiconductors and insulators applying the method of increments [1]. This method corresponds to a many-body expansion of the correlation energy of the solid in terms of localized entities. A generalization is possible for metals, where two major problems have to be faced: First, a straight-forward localization of the orbitals is not possible, localized entities have to be generated via an embedding scheme. Second is the difference between bulk metals and metal clusters. Within an infinite metal there is a homogeneous distribution of the conduction electrons, whereas in a cluster the charge will move to the surface. In order to apply local wavefunction-based correlation methods to metals using finite fragments of the solid, it is necessary to construct an embedding for these finite entities in such a way that the metallic character is simulated properly. For this purpose we suggest an embedding which has itself no metallic character but can mimic the metal in the internal region, where the atoms are correlated. Here we present different ways to construct such an embedding and discuss the influence of the embedding on the correlation energy of the solid.

[1] B. Paulus, Phys. Rep. 428, 1 (2006).

TT 20.56 Wed 14:00 Poster A

Mean-field theory of quadrupolar ordering in $YbRu_2Si_2$ — •Tetsuya Takimoto and Peter Thalmeier — Max Planck Institute for Chemical Physics of Solids, Dresden, Germany

We study theoretically quadrupolar ordering in $YbRu_2Si_2$. At first, we construct an effective Hamiltonian with two Kramers doublets, which consists of CEF, Zeeman, and inter-site interaction terms. In the inter-site term, there are interactions between multipoles which are classified according to the irreducible representations of the point group. Applying mean-field theory, we calculate the H-T phase diagram, order parameters, and the magnetic susceptibility. Comparing our results with experimental data, we identify the type of quadrupolar ordering observed in $YbRu_2Si_2$ as ferro-ordering of quadrupole O_2^2.

TT 20.57 Wed 14:00 Poster A

Realistic description of TTF-TCNQ using massively parallel exact diagonalization — •Andreas Dolfen and Erik Koch — Institut für Festkörperforschung, Forschungszentrum Jülich, Germany

The photoemission spectrum of the quasi one-dimensional organic metal TTF-TCNQ can be described qualitatively using a t-U Hubbard model. For such calculations we have developed a parallel Lanczos code which runs efficiently on modern massively parallel supercomputers like JUBL, Jülich's new BlueGene/L system. To overcome the limitations of the finite system-size we employ cluster perturbation theory (CPT), giving us access to the angular-resolved spectral function with high resolution. As a result, we can resolve the spin-charge separation. Moreover, we compute the total energy of the system by using the Galitskii-Migdal theorem.

Experiments and theoretical estimates for TTF-TCNQ suggest a value for the hopping parameter t. The parameter needed to fit the experiment is, however, larger by a factor of two. We resolve this problem by including realistic values for the next-neighbor interaction V into the model. The effect of this longer-range Coulomb interaction is to broaden the spectrum – very similar to increasing the value of t. This explains why the ad-hoc doubling of t yields a good comparison with experiment. Moreover, we find that the effect of V can be understood already in first-order perturbation theory.

TT 20.58 Wed 14:00 Poster A

Antiferromagnetism and Anderson localization of correlated lattice fermions with disorder — •Krzysztof Byczuk[1], Walter Hofstetter[2], and Dieter Vollhardt[1] — [1]Theoretical Physics III, Center for Electronic Correlations and Magnetism, Institute for Physics, University of Augsburg, D-86135 Augsburg, Germany — [2]Institut fur Theoretische Physik, Johann Wolfgang Goethe-Universitaet, 60438 Frankfurt/Main, Germany

The phase diagram of correlated, disordered lattice fermions is determined within dynamical mean–field theory supplemented by the geometrically averaged ("typical") local density of states. Antiferromagnetic insulator, Mott insulator and Anderson insulator phases are found to be separated by continuous phase transitions. Predictions for cold fermionic atoms on optical lattices and solid state systems are presented.

TT 20.59 Wed 14:00 Poster A

Local moment approach as an impurity solver of multi-orbital dynamical mean-field theory for correlated electrons — Anna Kauch[1] and •Krzysztof Byczuk[2,1] — [1]Institute of Theoretical Physics, Warsaw University, ul. Hoza 69, PL-00-681 Warszawa, Poland — [2]Theoretical Physics III, Center for Electronic Correlations and Magnetism, Institute for Physics, University of Augsburg, D-86135

Augsburg, Germany

A modified local moment approach is developed, and is applied as an impurity solver of the dynamical mean-field equations for the multiorbital Hubbard model. Assuming the existence of local moments their values are determined through a variational principle by minimizing the corresponding ground state energy. The method is applied to study the Mott metal-insulator transition in the multi-orbital Hubbard model.

[1] A. Kauch and K. Byczuk, Physica B 378-380, 297 (2006). [2] A. Kauch and K. Byczuk, Proceedings of Leschouches summer school, to be published (2007). [3] D. Logan, M.P. Eastwood and M.A. Tusch, J. Phys. Cond. Matter 10, 2673 (1998).

TT 20.60 Wed 14:00 Poster A

Effect of disorder on ferromagnetism in the periodic Anderson model within dynamical mean-field theory — •Unjong Yu, Krzysztof Byczuk, and Dieter Vollhardt — Theoretical Physics III, Center for Electronic Correlations and Magnetism, Institute for Physics, University of Augsburg, D-86135 Augsburg, Germany

Dynamical mean-field theory (DMFT) has been successfully applied to study of magnetism in strongly correlated systems, especially the Hubbard model [1] and the periodic Anderson model (PAM) [2]. DMFT was also shown to be an adequate tool to investigate the effect of disorder on magnetism in the Hubbard model [3]. In this presentation, we examine the stability of ferromagnetism in the PAM in the presence of binary alloy disorder by using the DMFT together with the quantum Monte-Carlo method. The magnetic phase diagram of the PAM as a function of disorder strength and alloy concentration as well as a carrier density is discussed.

[1] D. Vollhardt, N. Blümer, K. Held, M. Kollar, J. Schlipf, M. Ulmke, and J. Wahle, Advances in Solid State Physics **38**, 383 (1999).

[2] A. N. Tahvildar-Zadeh, M. Jarrell, and J. K. Freericks, Phys. Rev. B **55**, R3332 (1997).

[3] K. Byczuk, M. Ulmke, and D. Vollhardt, Phys. Rev. Lett. **90**, 196403 (2003).

TT 20.61 Wed 14:00 Poster A

Inhomogenous Hubbard model for solids and optical traps — •Rolf Helmes, Luis Craco, and Achim Rosch — Institute of Theoretical Physics, University of Cologne, Zülpicher Str. 77, 50937 Cologne

Inhomogenous systems described by the Hubbard model occur in several very interesting fields of physics: e.g., phase separation and the physcis of domain walls control the properties of manganites, see e.g. [1]. We therefore study domain walls between different phases of the Hubbard model. The interplay of domain walls and their energetics on the one hand and of long-range Coulomb interaction on the other hand, control for example the physics of phase-separation close to a first-order metal-insulator transition. Another example of an inhomogenous Hubbard-model system are fermions in an optical lattice. Here parameters can be tuned such that an "Mott-insulating onion shell" separates two metallic regions in a 3D-trap. We use a generalization of dynamical mean field theory (DMFT) to treat these inhomogeneous correlated systems.

[1] Cheong et al., Nature 2002, 416(6880),518-521

TT 20.62 Wed 14:00 Poster A

Metal-to-insulator transitions in the two-plane Hubbard model — •David Heilmann — (dann:) Institut für Festkörperforschung, Forschungszentrum Jülich, 52425 Jülich — (noch:) Phys. Institut der Universität Bonn, Nussallee 12, 53115 Bonn

The question if a Mott insulator and a band insulator are fundamentally different has been the matter of intensive research recently. Here we consider a simple model which allows by tuning one parameter to go continously from a Mott insulator to band insulator. The model consists of two Hubbard systems connected by single particle hopping. The Hubbard Hamiltonian is solved by the Dynamical Mean-Field theory using Quantum Monte Carlo. The quasiparticle spectral function, the opticall conductivity and the self-energy is calculated. Here we particularly focus on the Drude weight.

TT 20.63 Wed 14:00 Poster A

Magnetic properties of correlated electrons coupled to localized spins — •Robert Peters and Thomas Pruschke — Institut für theoretische Physik, Friedrich-Hund-Platz 1, 37077 Göttingen

We calculated the magnetic phase diagram of a correlated band coupled to localized spins at each lattice site. This model can be used for d-electrons in cristalline fields where the lower subbands are partially filled and form a local spin which couples to itinerant and interacting electrons. The method we use is the Dynamical Mean Field theory with the Numerical Renormalization group as impurity solver. We observe antiferromagnetism as well as ferromagnetism. We also discuss the behaviour of the MIT at half-filling.

TT 20.64 Wed 14:00 Poster A

Sum rules and vertex corrections for electron-phonon interaction — •Oliver Rösch[1,2], Giorgio Sangiovanni[1], and Olle Gunnarsson[1] — [1]Max-Planck-Institut für Festkörperforschung, Stuttgart — [2]Institut für Theoretische Physik, Universität zu Köln

We derive sum rules for the phonon self-energy and the electron-phonon contribution to the electron self-energy of the Holstein-Hubbard model in the limit of large Coulomb interaction U. Their relevance for finite U is investigated using exact diagonalization and dynamical mean-field theory. Based on these sum rules, we study the importance of vertex corrections to the electron-phonon interaction in a diagrammatic approach. We show that they are crucial for a sum rule for the electron self-energy in the undoped system while a sum rule related to the phonon self-energy of doped systems is satisfied even if vertex corrections are neglected. [1]

[1] O. Rösch *et al.*, Phys. Rev. B (accepted); cond-mat/0607612.

TT 20.65 Wed 14:00 Poster A

One- and two-particle excitations in the doped 2-dim. Hubbard model; a DCA calculation — •Stephan Hochkeppel, Fakher Assaad, and Werner Hanke — University of Wuerzburg, Wuerzburg, Germany

Using the Dynamical Cluster Approximation (DCA) and quantum Monte Carlo as a cluster solver we compute the single particle spectral functions of the electron and hole doped Hubbard model as a function of temperature. We allow U(1) as well as SU(2) symmmetry breaking baths so as to access superconducting states as well as antiferromagnetic order.
Two-particle quantities are computed within an extended RPA scheme where a dynamical vertex is extracted from the cluster and dressed Green function are used to calculate the bubble. The quality of the RPA approach is tested by comparing the resulting Neel temperature to that obtained by allowing for symmetry breaking within the DCA. Furthermore at high temperatures the collective spin excitations are compared with exact Monte Carlo simulations. Finally the temperature dependence of the single particle spectral function from the paramagnetic phase to superconducting state is studied in detail, the aim being a detailed study of the evolution of the pseudogap.

TT 20.66 Wed 14:00 Poster A

Numerical calculation of Wegner estimates for the three-dimensional Bernoulli-Anderson model — •Peter Karmann and Michael Schreiber — Institut für Physik, Technische Universität Chemnitz, 09107 Chemnitz

The Bernoulli-Anderson model is defined as a tight-binding Hamiltonian of non-interacting electrons with a probability distribution of the on-site energies given by a dichotomic or binary measure $\mu = p\delta_0+(1-p)\delta_W$. We study characteristic features of the density of states using various methods for the numerical diagonalization of sparse matrices. In particular, we determine an upper bound of the probability of finding an eigenvalue near a fixed energy for different system sizes and disorder strengths W. Especially for strong disorder, we give a Wegner estimate for resonances which can be identified with finite-size clusters.

TT 20.67 Wed 14:00 Poster A

Pseudogap and the spin-polaron band in the Hubbard model — •Alexei Sherman[1] and Michael Schreiber[2] — [1]Institute of Physics, University of Tartu, 51014 Tartu, Estonia — [2]Institut für Physik, Technische Universität, D-09107 Chemnitz, Germany

The spectra of the t-U and t-t'-U Hubbard models are investigated in the one-loop approximation for different values of the electron filling. It is shown that the four-band structure which is inherent in the case of half-filling and low temperatures persists also for some excess or deficiency of electrons. Besides, with some departure from half-filling an additional narrow band of quasiparticle states arises near the Fermi level. The dispersion of the band, its bandwidth and the variation with filling are close to those of the spin-polaron band of the t-J model. For

moderate doping spectral intensities in the new band and in one of the inner bands of the four-band structure decrease as the Fermi level is approached which leads to the appearance of a pseudogap in the spectrum.

TT 20.68 Wed 14:00 Poster A

From antiferromagnetism to singlet phase in the Double Bethe lattice — •Hartmut Hafermann[1], Mikhail Katsnelson[2], and Alexander Lichtenstein[1] — [1]I. Institute für Theoretische Physik, Universität Hamburg, D-20355 Hamburg — [2]Institute for Molecules and Materials, Radboud University Nijmegen, 6525 ED Nijmegen, The Netherlands

We consider a model of two coupled Bethe lattices with hopping t on each sublattice, perpendicular hopping $t_\perp$ between the lattices and an on-site repulsion U. We studied the magnetic phase transition from the antiferromagnetic to the non-magnetic state as a function of perpendicular hopping within the Continuous-Time Quantum Monte Carlo approach. For sufficiently large values of U, the transition is found to occur at $t_\perp/t = \sqrt{2}$. By measuring the total spin, it is shown that the non-magnetic state is a singlet state. We further map out the $t_\perp$-U-phase diagram.

TT 20.69 Wed 14:00 Poster A

Wither the sliding Luttinger liquid phase in the planar pyrochlore — •Marcelo Arlego[1] and Wolfram Brenig[2] — [1]Institut für Theoretische Physik, Technische Universität Braunschweig, 38106 Braunschweig, Germany — [2]Institut für Theoretische Physik, Technische Universität Braunschweig, 38106 Braunschweig, Germany

Using series expansion based on the flow equation method we study the zero temperature properties of the spin$-1/2$ planar pyrochlore antiferromagnet in the limit of strong diagonal coupling. Starting from the limit of decoupled crossed dimers we analyze the evolution of the ground state energy and the elementary triplet excitations in terms of two coupling constants describing the inter dimer exchange. In the limit of weakly coupled spin$-1/2$ chains we find that the fully frustrated inter chain coupling is critical, forcing a dimer phase which adiabatically connects to the state of isolated dimers. This is inconsistent with a two-dimensional sliding Luttinger liquid phase at finite inter chain coupling.

TT 20.70 Wed 14:00 Poster A

Spinon Deconfinement at the Quantum Critical Point of 2+1 D Antiferromagnets — •Zaira Nazario[1] and David Santiago[2] — [1]Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Str. 38, 01187 Dresden, Germany — [2]Insituut-Lorentz, Leiden University, P.O. Box 9506, NL-2300 RA Leiden, The Netherlands

The natural spin 1 excitations of 2+1 D antiferromagnets are made of constituent confined quarks of spin 1/2, spinons. The quantum paramagnetic phase possesses quantum tunneling events or instantons, which confine the spinons. There have been recent suggestions of new critical points where spinons are deconfined. Instanton events which cause the spinon confinement disappear at the deconfined critical point because the massless spinons screen them effectively and because instanton tunneling becomes infinitely costly. We point out that this happens irrespective of the intrinsic spin of the antiferromagnet. Hence spinons are deconfined irrespective of microscopic spin. Berry phase terms relevant to the paramagnetic phase make the confinement length scale diverge more strongly for half-integer spins, next strongest for odd integer spins, and weakest for even integer spins. There is an emergent photon at the deconfined critical point, but the "semimetallic" nature of critical spinons screens such photon making it irrelevant to long distance physics and the deconfined spinons behave as strictly free particles. A unique prediction critical free spinons at the quantum critical point is an anomalous exponent eta for the susceptibility exactly equal to one.

TT 20.71 Wed 14:00 Poster A

Non-Abelian Statistics in a Quantum Antiferromagnet — •Ronny Thomale and Martin Greiter — Institut für Theorie der Kondensierten Materie, D 76128 Karlsruhe

Non-abelian anyons are traditionally associated with the Pfaffian state for an incompressible quantum Hall state at filling fraction $\nu = 1/2$, a state thought to be realized experimentally in the second Landau level, *i.e.*, at $\nu = 5/2$. The characteristic property is that states with many non-abelian anyons possess an internal degeneracy. The internal space configuration changes as the particles are adiabatically interchanged, *i.e.*, the space is spanned by the different permutations of otherwise identical particles. Since the internal configurations are insensitive to external perturbations which do not move the particles, non-abelian anyons have received exceptional interest in the field of quantum computing. In this work, we present a universality class of two dimensional spin liquids for spin 1 antiferromagnets which support spinon excitations obeying non-abelian statistics. We motivate a Hamiltonian which we expect to stabilize these spin liquids.

TT 20.72 Wed 14:00 Poster A

Auxiliary Fermions and The Popov–Fedotov-Trick: Application to The Phase Diagram of The Bi-Layer Heisenberg Model — •Johannes Reuther, Jan Brinckmann, and Peter Woelfle — Institut f. Theorie der Kondensierten Materie, Universität Karlsruhe

We consider the antiferromagnetic spin-1/2 quantum Heisenberg model for two coupled planes. Each plane consists of spins on a two-dimensional square lattice with a nearest-neighbor coupling $J > 0$, while the planes are connected by another antiferromagnetic coupling $J_\perp$. As is well known, for $J_\perp = 0$ the decoupled planes feature a Néel-like groundstate, while for very large $J_\perp$ the formation of local spin singlets (valence-bond state) is evident.

We use the auxiliary-fermion formulation of spin operators in conjunction with a method proposed by Popov and Fedotov. The latter enables us to take *exactly* into account the auxiliary-particle constraint (i.e., the projection onto the physical Hilbert space).

The ground-state phase diagram of the model is calculated, using a simple diagrammatic approximation for the fermion's self energy. We find a Néel state at small $J_\perp$ and a continuous transition into a valence-bond state (VBS) if $J_\perp$ is increased beyond a critical value. The VBS is characterized by short-range correlations and gapped spin excitations. At the transition point the gap vanishes continuously, and the spin-1 spectrum becomes the magnon dispersion of the Néel state.

The magnetization and the evolution of the spin-excitation spectra as function of $J_\perp$ are compared to the literature.

TT 20.73 Wed 14:00 Poster A

Density functional theory for spinless fermions in one dimension — •Stefan Schenk, Peter Schwab, and Ulrich Eckern — Universität Augsburg

Density functional theory (DFT) within the local density approximation is well known to provide a realistic description of the electronic structure of numerous complex materials, including surfaces and interfaces.

Useful insights into the limitations of DFT can be obtained by considering simple lattice models [1]. In this context, we investigate a one-dimensional model of spinless fermions. An advantage of this model is that the exact exchange-correlation energy of the homogeneous system can be obtained by use of the Bethe-Ansatz. Starting from this exact calculation we employ two methods, the local density approximation and an approximation which includes the exact exchange energy. We compare with results obtained by exact diagonalisation of small systems.

In a next step we include magnetic fields. Therefore we extend the DFT to current density functional theory on a lattice. As in the previous case we investigate the accuracy of our methods by comparison with exact results.

[1] K. Schönhammer, O. Gunnarsson, and R. M. Noack, Phys. Rev. B **52**, 2504 (1995)

TT 20.74 Wed 14:00 Poster A

On Heat Conduction in Spin Chain Compounds — •Peter Jung[1], Rolf Helmes[1], Efrat Shimshoni[2], and Achim Rosch[1] — [1]Institut für Theoretische Physik, Universität zu Köln, Zülpicher Str. 77, 50937 Köln, Germany — [2]Deptartment of Mathematics and Physics, University of Haifa at Oranim, Qiryat-Tivon 36006, Israel

In recent measurements on spin chain compounds an unexpectedly high contribution to the heat conductivity at intermediate temperatures has been observed. Starting point of the presented analysis is the observation that the Spin-1/2 XXZ-model is integrable, resulting in an infinite heat conductivity. Additional couplings destroy the integrability and relax the heat current. We analyze the effect of various couplings on the heat conductivity, with special emphasis on the breakdown of integrability. We aim towards a complete understanding of the mechanisms of relaxation leading to the experimental results, including disorder effects and the coupling to phonons.

TT 20.75 Wed 14:00 Poster A

Spinon confinement and the Haldane gap of SU(n) spin chains — •Stephan Rachel and Martin Greiter — Institut für Theorie der Kondensierten Materie, Universtität Karlsruhe, Postfach 6980, 76128 Karlsruhe, Germany

To begin with, we introduce several exact models for SU(3) spin chains: (1) a translationally invariant parent Hamiltonian involving four-site interactions for the trimer chain, with a three-fold degenerate ground state. We provide numerical evidence that the elementary excitations of this model transform under representation $\bar{\mathbf{3}}$ of SU(3) if the original spins of the model transform under rep. **3**. (2) a family of parent Hamiltonians for valence bond solids of SU(3) chains with spin reps. **6**, **10**, and **8** on each lattice site. We argue that of these three models, only the latter two exhibit spinon confinement and hence a Haldane gap in the excitation spectrum. We generalize some of our models to SU(n). Finally, we use the emerging rules for the construction of VBS states to argue that models of antiferromagnetic chains of SU(n) spins in general possess a Haldane gap if the spins transform under a representation corresponding to a Young tableau consisting of a number of boxes λ which is divisible by n. If λ and n have no common divisor, the spin chain will support deconfined spinons and not exhibit a Haldane gap. If λ and n have a common divisor different from n, it will depend on the specifics of the model including the range of the interaction.

[1] M. Greiter, S. Rachel, and D. Schuricht, submitted to PRB.
[2] M. Greiter and S. Rachel, submitted to PRB.

TT 20.76 Wed 14:00 Poster A

Dominant particle-hole contributions to the phonon dynamics in the spinless one-dimensional Holstein model — •Steffen Sykora, Arnd Hübsch, and Klaus Becker — Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany

In the spinless Holstein model at half-filling the coupling of electrons to phonons is responsible for a phase transition from a metallic state at small coupling to a Peierls distorted insulated state when the electron-phonon coupling exceeds a critical value. For the adiabatic case of small phonon frequencies, the transition is accompanied by a phonon softening at the Brillouin zone boundary whereas a hardening of the phonon mode occurs in the anti-adiabatic case. The phonon dynamics studied in this poster do not only reveal the expected renormalization of the phonon modes but also show remarkable additional contributions due to electronic particle-hole excitations.

TT 20.77 Wed 14:00 Poster A

The one-dimensional Hubbard model: A benchmark for variational cluster approximations — •Matthias Balzer, Michael Potthoff, and Werner Hanke — Institut für Theoretische Physik und Astrophysik, Universität Würzburg, Am Hubland D-97074 Würzburg

Important physical properties of lattice models of strongly correlated electrons are often dominated by short-range spatial correlations. Starting from the purely local (atomic) physics, short-range correlations can be included step by step within cluster approximations generated by the self-energy-functional theory. The one-dimensional Hubbard model is considered to benchmark various cluster schemes: the plain cluster perturbation theory (CPT), the variational cluster approach (VCA) using different sets of variational parameters as well as extensions of the VCA including bath degrees of freedom. Calculations are performed at zero temperature for clusters up to 10 sites. The results for the filling dependence of the chemical potential and the transition to the Mott insulator are compared to the exact Bethe ansatz. Several questions concerning thermodynamical consistency, cluster boundary conditions, optimal choice of variational parameters, spectral functions etc. are investigated. The applications of variational cluster methods for the study of the filling-controlled Mott transition in two dimensions are discussed.

TT 20.78 Wed 14:00 Poster A

Efficient simulation of one-dimensional many-body quantum systems — •Alex Cojuhovschi, Malcolm Einhellinger, and Eric Jeckelmann — Institut für Theoretische Physik, Leibniz Universität Hannover

Vidal's time-evolving block decimation (TEBD) algorithm allows for the accurate simulation of the ground state and the time evolution in one-dimensional many-body quantum systems. Although density-matrix renormalization group (DMRG) methods seem more versatile and efficient than the TEBD algorithm on sequential computers, extensively parallelized DMRG codes have shown a good scalability only up to 8 or 16 processors, which severely restricts their use on modern parallel supercomputers. We show that the TEBD algorithm can be easily parallelized and has a much better scalability than DMRG codes for large systems. This could enable the use of massively parallel computers for this type of simulations.

Furthermore, we have investigated the time-evolution of the density-matrix spectrum in non-interacting electron systems out of equilibrium such as two reservoirs coupled through a quantum dot. This allows us to devise more efficient procedures for simulating large non-interacting subsystems (such as charge or heat reservoirs) in DMRG and TEBD approaches to the time evolution of quantum systems.

TT 20.79 Wed 14:00 Poster A

Deconvolution procedures for dynamical DMRG spectra — •Martin Paech and Eric Jeckelmann — Institut fuer Theoretische Physik, Leibniz Universitaet Hannover

The dynamical density-matrix renormalization group (DDMRG) method provides the frequency-dependent correlation functions of finite-size low-dimensional systems with great accuracy. The spectrum of an infinite system can be obtained for each frequency separately using a finite-size scaling analysis of the DDMRG data. We have shown previously that the infinite-system spectrum can sometimes be obtained at a much lower computational cost by a deconvolution of the finite-system DDMRG data under some regularity assumptions for the spectrum. Although standard algorithms for inverse problems such as a deconvolution yield good results for smooth continuous spectra they fail if the spectrum includes singularities. We discuss several deconvolution procedures for general spectra and illustrate them with a study of the density of states in one-dimensional correlated electron systems.

TT 20.80 Wed 14:00 Poster A

Improved scaling for the Matrix Product State alternative to DMRG — •Peter Pippan[1], Steven White[2], and Hans Gerd Evertz[1] — [1]Theor. and Comput. Physics, TU Graz, 8010 Graz, Austria — [2]Dept of Physics and Astronomy, UC Irvine, CA 92697, USA

The density-matrix renormalization group (DMRG) is a highly efficient algorithm for the investigation of low-dimensional, strongly correlated systems. It converges to the ground state, which can be written as a matrix product state. We study a recently proposed variational method that optimizes these matrix product states independently of DMRG. This method proofs useful for periodic boundary conditions and is conceptually more powerfull than DMRG, but is numerically much less efficient. We introduce a decomposition of large matrices using a singular value decomposition (SVD). Neglecting small singular values, we approximate the matrices very accurately while keeping storage requirements small. The computational effort and especially its scaling with system size is then drastically reduced, while accuracy remains unchanged. This allows the investigation of much larger systems with periodic boundary conditions. Properties of the new method are studied for the Spin 1 Heisenberg chain.

TT 20.81 Wed 14:00 Poster A

Phonon simulations with arbitrary dispersions — •Hans Gerd Evertz, Franz Michel, and Peter Pippan — Theoretical and Computational Physics, TU Graz, 8010 Graz, Austria

We describe a new Quantum Monte Carlo method that allows the efficient simulation of phonons with arbitrary bare dispersion, coupled to spins in any dimension, or to 1d electrons.

We examine the spin Peierls transition in 1d in the case of optical phonons and of acoustical phonons and show that it occurs at the *same* coupling. Detailed phonon spectra exhibit both a central peak and softening, depending on the bare phonon frequency at momentum π. In 2d we examine the stripe pattern of coupled chains. We contrast the behavior of spin-phonon systems to that of coupled electrons and phonons.

TT 20.82 Wed 14:00 Poster A

Fermi-edge singularities in the mesoscopic regime — •Martina Hentschel — MPIPKS Dresden, Nöthnitzer Str. 38, 01187 Dresden

Motivated by the experimental progress in the field of mesoscopic physics and quantum chaos over the past years, we study the many-body effects contributing to Fermi-edge singularities in the x-ray edge problem for mesoscopic systems and compare the results with the well-understood metallic case. Upon absorption of an x-ray, a core electron

is excited into the conduction band, and the core hole left behind constitutes a sudden, localized perturbation. It entails two counteracting many-body responses, namely Anderson orthogonality catastrophe and Mahan's exciton, that affect the photoabsorption cross section. Using a rank-one model and a Fermi golden rule approach, we find characteristic deviations from the metallic case that originate in the small system size, mesoscopic fluctuations, and most notably the coherent dynamics of conduction electrons in mesoscopic systems like quantum dots or metallic nanoparticles. We investigate the dependence of the photoabsorption spectra on the number of electrons and argue that our predicitons are observable using nowadays experimental technology.

TT 20.83 Wed 14:00 Poster A

Anderson Orthogonality Catastrophe in Mesoscopic Systems — •Georg Röder, Swarnali Bandopadhyay, and Martina Hentschel — Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Strasse 38, 01187 Dresden, Germany

Anderson orthogonality catastrophe (AOC) is an universal many-body response of an electron gas subject to a sudden, localised perturbation. It refers to the vanishing of overlap of the unperturbed and perturbed many-body ground states in the thermodynamic limit. Here, we study AOC in mesoscopic systems where the finite number of electrons, the confining geometry, interference effects and mesoscopic fluctuations give rise to novel behaviours not seen in bulk systems. In particular we consider two dimensional regular structures such as disc-like and rectangular quantum wells and realistic few electron quantum dots with parabolic confinement potential. Comparing the results with the chaotic case [M. Hentschel, D. Ullmo, and H. U. Baranger, Phys. Rev. Lett. **93**, 176807 (2004)], we find characteristic differences such as shell effects. Our model of a rank-one perturbation describes, e.g., the core hole created in a x-ray absorption process where the AOC response of the system is experimentally accessible through the photoemission cross section.

TT 20.84 Wed 14:00 Poster A

Low-density expansion for the two-dimensional electron gas — •Francesca Sauli and Peter Kopietz — Institut für Theoretische Physik, J.W. Goethe Universität, Frankfurt am Main

We show that in two dimensions ($2D$) a systematic expansion of the self-energy and the effective interaction of a dilute electron gas in powers of the two-body T-Matrix T_0 can be generated from an exact hierarchy of the functional renormalization group equations for one-particle irreducible vertices using the chemical potential as flow parameter. Due to the interference of particle-particle and particle-hole channels at order $T_0 2$, in $2D$ the ladder approximation for the self-energy is not reliable beyond the leading order in T_0. We also discuss two-body scattering in vacuum in arbitrary dimensions from the renormalization group point of view and argue that the singular interaction proposed by Anderson [Phys. Rev. Lett. **65**, 2306 (1990)] cannot be ruled out on the basis of the ladder approximation.

TT 21: Solids at Low Temperature - Poster Session

Time: Wednesday 14:00–17:45 Location: Poster A

TT 21.1 Wed 14:00 Poster A

Mixtures of bosons and fermions in optical lattices — •Irakli Titvinidze, Michiel Snoek, and Walter Hofstetter — Institut für Theoretische Physik Johann Wolfgang Goethe-Universität, Max-von-Laue-Str. 1, 60438 Frankfurt am Main, Deutschland

We study a mixture of bosonic and fermionic atoms in an optical lattice using Dynamical Mean Field Theory. The bosons and fermions interact via on-site Hubbard interactions. In addition, there is a on-site interaction between the bosons and the fermions. Since all interaction parameters can independently be chosen to be repulsive or attractive, this system exhibits an exceedingly rich phase diagram. We pay particular attention to the effect of the bosons on antiferromagnetism and the shifting of bosonic Mott transition due to the presence of the fermions. This model can be extended by a Feshbach term, which transform a bosonic molecule into two fermionic atoms and vice versa.

TT 21.2 Wed 14:00 Poster A

Density Correlations in Ultracold Atomic Fermi Gases via the Richardson Solution — •Simon Staudenmayer[1], Christoph Bruder[2], and Wolfgang Belzig[1] — [1]Universitaet Konstanz, Fachbereich Physik, D-78457 Konstanz — [2]Institut fuer Physik, Klingelbergstr. 82, CH-4056 Basel

Ultracold fermionic atomic gases have attracted considerable attention both from a theoretical and experimental point of view recently. The crossover from a Bose-Einstein condensate (BEC) of strongly bound molecules to a weakly interacting Bardeen-Cooper-Schrieffer (BCS)-like state is of particular interest. Investigations of this BEC-BCS crossover and the ability to tune the mutual interaction between atoms in one and the same system via a Feshbach resonance are interesting from a fundamental many-body point of view. The BEC-BCS transition also yields a crossover in the statistics of number densities: the statistics is Poissonian on the BEC side and binomial on the BCS side [1]. We therefore present a method, adapting the concept of full counting statistics, that has the potential to be used as an experimental tool to gain information on the many-body ground state. Correlators of a canonical fermionic system are obtained using the so-called Richardson solution, i.e., the exact eigenstates of the BCS pairing hamiltonian. [1] W. Belzig, C. Schroll and C. Bruder, cond-mat/0412269

TT 21.3 Wed 14:00 Poster A

Strongly interacting bose gas in an optical lattice. — •Oleksandr Fialko, Christopher Moseley, and Klaus Ziegler — Institut für Physik, Universität Augsburg, Germany

We study the Bose-Hubbard model, projected onto the regions where two Mott-insulating phases merge. These projections can be described by a hard-core Bose gas which can be treated by locally paired spin-1/2 fermions.

This effective fermion model is analyzed in terms of a mean-field approximation and Gaussian fluctuations. The mean-field solution gives us the phase diagram with the two merging Mott insulators and an intermediate superfluid. The effect of quantum and thermal fluctuations are investigated. In particular, we study the role of gapless and gapped modes in the fluctuations, and calculate the static structure factor.

TT 21.4 Wed 14:00 Poster A

Fermionic Hubbard model with spin-dependent hopping amplitudes for ultracold quantum gases — •Tobias Gottwald and Peter G. J. van Dongen — KOMET 337, Institut für Physik, Universität Mainz, Staudingerweg 7, 55099 Mainz

In order to understand the properties of fermionic ultracold quantum gases in optical lattices, we analyze a Hubbard model with spin-dependent hopping amplitudes at low temperatures in the limits of weak and strong coupling. In both cases we consider attractive as well as repulsive interactions, for which we find suprafluidity and (generalized) antiferromagnetism, respectively. In experiment, interactions can be tuned via Feshbach resonances, and different hopping amplitudes arise from different atomic masses or different hyperfine states. We investigate this generalized Hubbard model between two extremes, on the one hand the Falicov-Kimball model and on the other the standard Hubbard model with equal hopping amplitudes for each pseudo-spin species.

TT 21.5 Wed 14:00 Poster A

Extended mean-field theory for disordered bosons in optical lattices — •Ulf Bissbort and Walter Hofstetter — Institut für Theoretische Physik, J.W. Goethe-Universität, D-60438 Frankfurt, Germany

We consider bosons in disordered optical lattices at zero temperature for various disorder realizations in a mean-field approximation of the Hubbard model. Hitherto the problem of random on-site disorder was tackled using modifications of the usual single site mean-field theory or spatially resolved methods, which use a limited number of sites. We propose a new extended mean-field theory, which takes dimensional effects into account and is applicable in the thermodynamic limit. Within this method we suggest criteria to distinguish between the Mott insulating, the Bose glass and the superfluid phases. Results

are presented for the ground-state phase diagram and experimental accessibility is discussed.

TT 21.6 Wed 14:00 Poster A

Transport of Bose-Einstein condensates through two-dimensional disorder potentials — •Michael Hartung, Klaus Richter, and Peter Schlagheck — Institute for Theoretical Physics, University of Regensburg, D-93040 Regensburg, Germany

The rapid progress in the experimental techniques for Bose-Einstein condensates permits detailed studies of mesoscopic transport dynamics of interacting matter waves with rather high accuracy and high flexibility in the control of parameters. We particularly focus on the transport of a Bose-Einstein condensate through a two-dimensional disorder potential. To this end we developed, in analogy with our previous study on one-dimensional condensate transport [1], a two-dimensional numerical method to simulate the time-dependent propagation process within the mean-field approximation of the condensate. We discuss the influence of the repulsive atom-atom interaction on the transport process of the condensate, and focus here in particular on the phenomena of coherent backscattering and weak localization.

[1] T. Paul, P. Leboeuf, N. Pavloff, K. Richter, and P. Schlagheck Phys. Rev. A **72**, 063621 (2005)

TT 21.7 Wed 14:00 Poster A

Mott transition and region of existence of excitonic BEC — •Felix Richter, Rico Schwartz, Tim Schmielau, Klaus Henneberger, and Heinrich Stolz — Institut für Physik, Universität Rostock, 18051 Rostock

We show predictions for the regions of existence of excitons and their BEC in the n, T-plane. Therefor we compute the lowering of the continuum edge as well as shifts in the exciton binding energy due to self-energy shifts. Degeneracy, correlation and exchange are taken into account. Former approaches to this problem yielded a large area of bistability. The exchange shift caused by the bound particles is shown to lead to a significantly smaller area of bistability, which is restricted to densities close to the Mott transistion.

In addition, our algorithm is capable of calculating the density of the condensate. In cuprous oxide, a BEC is predicted to build up at densities lower than that of the Mott transition, making up a considerable amount of the total density.

We compare our results for the binding energy shifts to absorption spectra obtained by pump-probe experiments, which allows for a more precise estimate of the total electron-hole-pair density at any temperature. This provides new insight into the balance between condensation and the Mott transition in an excitonic system.

TT 21.8 Wed 14:00 Poster A

Ultracold bosons in one-dimensional incommensurate superlattices — •Tommaso Roscilde and Juan Ignacio Cirac — Max-Planck-Institut fuer Quantenoptik, Garching b. Muenchen

Motivated by recent experiments (L. Fallani et al., cond-mat/0603655), we numerically investigate the ground-state properties of strongly interacting ultracold bosons in a one-dimensional quasi-periodic superlattice, modeled by the Bose-Hubbard Hamiltonian in an incommensurate cosine potential. In the weakly interacting regime, the incommensurate potential (IP) is known to lead to Anderson localization when exceeding a given critical strength. We find that strong repulsion, leading to a Mott-insulating state for the system without the IP, introduces an extremely rich physical scenario. For repulsion values away from the Tonks limit an IP added to the Mott phase is effectively screened by a fraction of the particles, and drives the system to a superfluid phase for the remaining fraction. For larger IPs a cascade of incompressible insulating states appears with incommensurate fractional fillings. The change of filling from a state to the next is usually accompanied by significant particle number fluctuations without superfluidity, namely by Bose-glass behavior in narrow parameter ranges.

TT 21.9 Wed 14:00 Poster A

Schnelle Spin Relaxation in festem ^{3}He bei mK Temperaturen — •Matthias Kath, Erwin Schuberth und Simone Bago — Walther-Meissner-Institut, 85748 Garching

Zur Aufklärung der Spinstruktur der kernspingeordneten Phasen von festem ^{3}He ist Neutronenstreuung einzigartig geeignet. Ausschlaggebend für dieses Experiment ist die Zucht von Einkristallen in feinporigen Sintern - einerseits um den Festkörper auf eine Temperatur im Bereich von 0,5 mK kühlen zu können, andererseits um einen Großteil der durch den n-Einfang entstehenden Wärme abzuführen.

In diesem Zusammenhang wurde die Zucht möglichst guter Einkristalle in Silbersintern mit unterschiedlicher Porengröße untersucht. Der Übergang in die kernspingeordneten Phasen konnte im Fall der U2D2-Phase durch den Abfall der NMR-Intensität, im Fall der Hochfeld-Phase durch einen Anstieg um ca. 30 % nachgewiesen werden. Unterhalb von $T_{\mathrm{Neel}} = 0{,}9\,\mathrm{mK}$ war die für die U2D2-Phase charakteristische Linienaufspaltung zu beobachten: Einerseits ca. 4 kHz auf der niederfrequenten Seite der Larmorlinie bei 240 kHz, andererseits ca. 20 kHz auf der hochfrequenten Seite bei 1980 kHz. T_2-Messungen in der paramagnetischen Phase ergaben einen Wert von $4{,}6 \pm 0.2$ ms. Bei T_1-Messungen zeigte sich ein unerwartet effektiver longitudinaler Relaxationsprozess, der einer gewöhnlichen T_1 Relaxation (250 ms bei 10 mK) vorgelagert war. Die schnelle anfängliche Relaxation von M_z beruht wahrscheinlich auf einem starken Entmagnetisierungsfeld der Probe. Sie verhinderte in der Nähe von T_{Neel} sogar gänzlich die Bestimmung des eigentlichen T_1.

TT 21.10 Wed 14:00 Poster A

Dynamical mean-field theory of half-metallic ferromagnets — •Eberhard Jakobi, Nils Blümer, and Peter van Dongen — KOMET 337, Institut für Physik, Universität Mainz, Staudingerweg 7, 55099 Mainz

Spintronics applications require materials with high spin polarization; therefore, half-metallic ferromagnets are of strong practical interest. Candidates for half-metallic behavior at sufficiently high temperatures include Heusler compounds as well as double perovskites. Previous studies for these materials were mostly restricted to density functional theory (DFT) within local spin-density approximation (LSDA). We investigate multi-band Hubbard models as relevant for half-metallic ferromagnets within Dynamical mean-field theory (DMFT) using weak-coupling perturbation theory and quantum Monte Carlo (QMC) simulations. Thereby we are able to treat electronic correlations beyond the level of conventional band structure calculations.

TT 21.11 Wed 14:00 Poster A

Magnetic and spectroscopic investigations of $SmCr_3(BO_3)_4$ — •Patric Scheib[1], Elena Popova[2], Alexander N. Vasiliev[2], I. Gugim[3], L. N. Bezmaternykh[3], Dirk Menzel[1], Joachim Schoenes[1], and Peter Lemmens[1] — [1]Institut für Physik der kondensierten Materie, TU Braunschweig, Braunschweig — [2]Faculty of Physics, Moscow State University, Moscow, Russia — [3]Kirensky Institute of Physics, Siberian Division, Russian Academy of Science, Krasnoyarsk, Russia

We report on the magnetic properties and structural investigation of a rare-earth chromium borate. This system is isostructural to the recently discussed multiferroic rare-earth iron borate $GdFe_3(BO_3)_4$. Magnetic Raman scattering and susceptibility show evidence for antiferromagnetic correlations within the Fe chains and a complex phase diagram. Work supported by DFG and ESF-HFM.

TT 21.12 Wed 14:00 Poster A

Spectroscopic and thermodynamic characterization of epitaxially grown $La_{1-x}Ca_xMnO_3$ films — Alexander Hirsch[1], Dirk Menzel[2], Ana Maria Racu[2], •Patric Scheib[2], Stefan Weber[2], Peter Lemmens[2], Joachim Schoenes[2], Wolfram Brenig[3], and Meinhard Schilling[1] — [1]Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik, TU Braunschweig, Braunschweig — [2]Institut für Physik der kondensierten Materie, TU Braunschweig, Braunschweig — [3]Institut für Theoretische Physik, TU Braunschweig, Braunschweig

$La_{1-x}Ca_xMnO_3$ (LCMO) thin films with different calcium concentrations are grown using Pulsed Laser Deposition (PLD). These films are characterised by optical spectroscopy, Raman scattering as well as SQUID measurements. Annealing studies demonstrate the interplay of oxygen nonstoichiometry and lattice mismatch on the substrate.

TT 21.13 Wed 14:00 Poster A

Low-temperature investigation of the thermal properties of glasses — •Astrid Netsch, Sabine Wolf, Andreas Fleischmann, and Christian Enss — Kirchhoff-Institut für Physik, Universität Heidelberg, INF 227, 69120 Heidelberg, Germany

The thermal conductivity of glasses at low temperatures is generally believed to be due to the propagation of phonons. However, a second transport channel for heat should exist in these materials because of the existence of tunneling systems that interact with each other and

allow for a diffusion of energy via resonant flip-flop processes. This contribution is expected to be much smaller than that due to phonons. In search of such a contribution we have performed measurements on two planar glass samples which contain holes of different size on a triangular lattice that serve as extra scatterers for phonons. For measuring thermal conductivity of such diminutive magnitude we used a SQUID-based contact-free technique because of its extremly small parasitic heating. Our results show that the thermal conductivity varies roughly with T^3 down to about 50 mK as expected for phonons in the boundary scattering regime. Below this temperature, the thermal conductivity follows a weaker power law. Though this is expected for thermal transport via mutually interacting tunneling systems the absolute value appears to be surprisingly high compared to theoretical predictions. Therefore it remains an open question whether the observed deviation is indeed caused by a non-phononic contribution, or whether this is a consequence of the wave length of the phonons becoming larger than the lattice constant of the array of holes.

TT 21.14 Wed 14:00 Poster A

Numerical simulation of the influence of nuclear moments on two- pulse polarization echoes in glassy glycerol — •Gudrun Fickenscher[1], Masoomeh Bazrafshan[1], Kathrin Reinhold[1], Marek Bartkowiak[2], Herbert Zimmermann[3], Andreas Fleischmann[1], and Christian Enss[1] — [1]Kirchhoff-Institut für Physik-Universität Heidelberg — [2]Forschungszentrum-Rossendorf-Dresden — [3]Max-Plank-Institut für Medizinische Forschung-Heidelberg

At low temperatures - below a few Kelvin - the properties of glasses are dominated by the tunneling motion of atomic tunneling systems in a double well potential. A few years ago it was shown that tunneling particles having a nuclear qudrupole moment experiencing electric field gradient cause magnetic field effects in non-magnetic glasses. This effect is observed using the method of two pulse polarization echoes, looking at the magnetic field dependence as well as the time dependence of echo amplitude. Recently, we observed that the presence of interacting magnetic dipole moments leads to qualitatively similar effects on a smaller magnetic scale. In this work we developed numerical techniques to simulate the amplitude of the two- pulse polarization echo, having flexibility of including any number of dipole and quadrupole moments corresponding to H and D atoms in partially deuterated samples. The simulations are done assuming a specific microscopic model of tunneling motion with specific distributions for tunneling parameters. The results of such simulations are presented comparing to experimental data.

TT 21.15 Wed 14:00 Poster A

Electronic transport properties of C-doped Mn_5Si_3 films — •B. Gopalakrishnan[1], Christoph Sürgers[1], and Hilbert v. Löhneysen[1,2] — [1]Physikalisches Institut, Universität Karlsruhe, D-76128 Karlsruhe — [2]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, D-76021 Karlsruhe

The incorporation of carbon into the antiferromagnetic Mn_5Si_3 compound gives rise to ferromagnetic order with a Curie temperature above room temperature. The microscopic origin of the C-induced ferromagnetism still needs to be explored. Here we report on the electronic transport properties of 100-nm thick $Mn_5Si_3C_x$ ($0 \leq x \leq 1.2$) films prepared by simultaneous magnetron sputtering of elemental Mn, Si, and C [1]. We observe distinct differences in the temperature dependence of the resistance R, magnetoresistance, and Hall effect of the ferromagnetic C-doped films compared to antiferromagnetic Mn_5Si_3. In particular, for films with an optimum doping level $x = 0.8$ inferred from previous magnetization measurements, we observe a metallic behavior of R and the lowest residual resistivity. At temperatures below 20 K a behavior $R \propto -\ln T$ is found, reminiscent of electron-electron interaction or weak-localization effects, although the films are much thicker than all relevant scattering lengths.

[1] C. Sürgers et al., Phys. Rev. B **68**, 174423 (2003)

TT 21.16 Wed 14:00 Poster A

Thermally and Optically Switched Spin States in $[Fe(pmd)(H_2O)\{Au(CN)_2\}_2] \cdot H_2O$. A revised phase diagram — Vladimir Gnezdilov[1], •Peter Lemmens[2], Patric Scheib[2], Yuri Georgii Pashkevich[3], Karina V. Lamonova[3], Elena S. Zhitlukhina[3], Virgine Niel[4], and Jose A. Real[4] — [1]Institute for Low Temperature Physics and Engineering, NASU, Kharkov, Ukraine — [2]Institut für Physik der kondensierten Materie, TU-Braunschweig, Braunschweig — [3]Donetsk Phystech, NASU, Ukraine — [4]Institut de Cienca Molecular / Departement de Química Inorg ànica, Iniversitat de València

Raman scattering in the spin-crossover $[Fe(pmd)(H_2O)\{Au(CN)_2\}_2] \cdot H_2O$ reveals a complex three-step spin-state transitions in contrast to observations in magnetization measurements. The switching between different spin states is recorded as function of temperature and irradiation with electromagnetic radiation in the visible spectral range. Work supported by DFG topical research center "Molecular Magnets" and ESF-HFM.

TT 21.17 Wed 14:00 Poster A

Analysis of mechanical loss processes of low loss materials for interferometric gravitational wave detectors in the low temperature range — •Daniel Heinert[1], Anja Zimmer[1], Ronny Nawrodt[1], Wolfgang Vodel[1], Andreas Tünnermann[2], and Paul Seidel[1] — [1]Institut für Festkörperphysik, FSU Jena, Helmholtzweg 5, 07743 Jena — [2]Institut für Angewandte Physik, FSU Jena, Albert-Einstein-Straße 15, 07745 Jena

Thermal noise introduced by mechanical losses is one main limitation in the detection frequency band of interferometric gravitational wave detectors. Cooling of the optical components could produce a relief insofar as materials featuring low mechanical losses at cryogenic temperatures are used. Influences of different loss mechanisms on the mechanical quality factor are presented, especially under consideration of the excited mode shape.

This work was supported by the DFG under contract SFB Transregio 7.

TT 21.18 Wed 14:00 Poster A

Mechanical Loss Measurements on Calcium Fluoride Bulk Material at Low Temperatures — •Christian Schwarz[1], Ronny Nawrodt[1], Anja Zimmer[1], Sandor Nietzsche[1], Wolfgang Vodel[1], Andreas Tünnermann[2], and Paul Seidel[1] — [1]Friedrich-Schiller-University Jena - Institute of Solid State Physics, Helmholtzweg 5, 07743 Jena, Germany — [2]Friedrich-Schiller-University - Institute of Applied Physics, Albert-Einstein-Straße 15, 07745 Jena, Germany

Interferometric gravitational wave detectors are one of the most sensitive devices ever developed. The detectors currently in use are limited by different kinds of noise. One of the fundamental noise sources is thermal noise. To lower thermal noise within the detection band it is necessary to use low mechanical loss materials as optical components.

One promissing candidate as a low loss material is calcium fluoride. Detailed measurements of the mechanical loss of single crystal calcium fluoride samples (Dia. 76.2 $mm \times 75$ mm) are presented within a temperature range from 5 to 300 K. The lowest loss was observed at 65 K as 3.6×10^{-9}. Possible damping mechanisms are discussed and compared with the experimental results.

This work was supported by the DFG under contract SFB Transregio 7.

TT 21.19 Wed 14:00 Poster A

Soft phonon modes in phase change materials — •Dominic Lencer[1], Blazej Grabowski[2], Jörg Neugebauer[2], and Matthias Wuttig[1] — [1]I. Physikalisches Institut (1A), RWTH Aachen, D-52056 Aachen — [2]Max-Planck-Institut für Eisenforschung, Max-Planck-Straße 1, D-40237 Düsseldorf

Among the candidates for non-volatile memories succeding Flash *phase change RAM (PCRAM)* is attracting much interest from basic and industrial research groups. It is based on reversible electrically induced switching of small cells between an amorphous and crystalline state.

In general, the employed metastable crystalline phases of alloys used for PCRAM devices resemble slightly distorted cubic structures. In order to investigate the particular distortions, phonon dispersions were calculated for the symmetric cubic phases of GeTe, Sb_2Te_3 and $GeSb_2Te_4$ using density functional calculations using both the linear response and a direct method. Soft phonon modes were identified and sampled to yield models for the distorted phases. Properties of both undistorted and distorted phases are presented and compared to experimental data.

TT 21.20 Wed 14:00 Poster A

Low-temperature phonon dispersion in 2H-$NbSe_2$ by inelastic neutron scattering and ab-inito calculations — •Karin Schmalzl[1,2], Arno Hiess[2], Dieter Strauch[3], and Helmuth Berger[4] — [1]Forschungszentrum Juelich, 52425 Juelich, Germany —

[2]Institut Laue Langevin, 38042 Grenoble, France — [3]Universitaet Regensburg, 93040 Regensburg, Germany — [4]Ecole Politechnique Federale de Lausanne, 1015 Lausanne, Switzerland

2H-$NbSe_2$ belongs to the group of quasi-two-dimensional layered transition metal dichalcogenides. The 2H polytypes consist of stacked hexagonal planes. Several interesting properties like superconductivity ($T_c \approx 7$ K), anisotropic electrical properties, incommensurate charge-density wave (CDW) instability ($T_{\mathrm{CDW}} \approx 35$ K), and very anisotropic k-dependent electron-phonon coupling are found. Also, many lattice properties like thermal expansion, sound velocity, etc. are very anisotropic. Superconductivity and CDW order coexist at low T.

It is suspected that in these systems there is a connection between the charge-density wave, a strongly anisotropic electron-phonon coupling, lattice distortion, and phonon anomalies. The CDW is slightly incommensurate with a wavevector near $\frac{1}{3}(1,0,0)$.

We have now investigated the low-frequency branches of the phonon dispersion at 50 K in frequency, width, and intensity, also along non-main-symmetry directions around the phonon wavector $\mathbf{q} = \frac{1}{3}(1,0,0)$ by inelastic neutron scattering. The experiments are accompanied by ab-initio calculations.

TT 22: Low-dimensional Systems - Materials

Time: Thursday 9:30–13:00 Location: H18

TT 22.1 Thu 9:30 H18

Doping effects in the low-dimensional spin-Peierls system TiOCl — •Sebastian Glawion[1], Götz Berner[1], Matthias Schlachter[1], Michael Sing[1], Markus Hoinkis[2], and Ralph Claessen[1] — [1]Experimentelle Physik 4 and Röntgen Research Center for Complex Materials, Universität Würzburg, D-97074 Würzburg, Germany — [2]Experimentalphysik II, Universität Augsburg, D-86135 Augsburg, Germany

Due to the underlying triangular mesh of Ti atoms, which favours magnetic frustration, it has been speculated that the Mott-insulator TiOCl could show RVB-like superconductivity, provided one can induce metallic behaviour. However, the observed non-canonical transition into a dimerized spin-Peierls phase at T_{c1}=67K and a Bonner-Fisher-like susceptibility above T_{c2}=92K point to a quasi-1D behaviour discarding such frustrations. Interestingly, as was indicated, e.g., by ARPES, 2D magnetic frustrations nevertheless might be important due to a small but non-negligible interchain coupling. Searching for a metallic phase, we investigated the feasibility of doping in different ways: in situ evaporation of alkaline atoms and compositional variation by ion bombardment. We found that there are qualitative differences between the two methods, such that in the latter case the near E_f spectral weight remains essentially unchanged while the onset of its leading edge is aligned with the chemical potential, and the dispersion is lost. On the other hand, a new feature appears in the gap region upon alkaline intercalation. The overall Ti 3d dispersions are retained but the gap is not fully closed.

TT 22.2 Thu 9:45 H18

Exotic Ground State of η-$Na_{9/7}V_2O_5$ — •Dmitry Zakharov[1,2], Hans-Albrecht Krug von Nidda[1], Günter Obermeier[3], Siegfried Horn[3], and Alois Loidl[1] — [1]EP V, EKM, University of Augsburg, 86135 Augsburg, Germany — [2]Kazan State University, 420008 Kazan, Russia — [3]EP II, Institut für Physik, Universität Augsburg, 86135 Augsburg, Germany

The nature of the ground gapped state in the novel quasi-one-dimensional compound η-$Na_{9/7}V_2O_5$ is rather mysterious, if one takes into account the odd number of spins on each structural element. Combining the results of specific heat, susceptibility, electron spin resonance and dielectric conductivity measurements we show that it can be understood in terms of multi-spin objects building up a linear chain. In spite of the small total spin, their spatial extent results in an exchange constant comparable to the one in the non-dimerized state.

TT 22.3 Thu 10:00 H18

Drude response and evidence of a density-wave state in the β'' – $(ET)_2SF_5CH_2CF_2SO_3$ organic superconductor — •Stefan Kaiser[1], Natalia Drichko[1], Martin Dressel[1], and John Schlueter[2] — [1]1. Physikalisches Institut, Universität Stuttgart, 70550 Stuttgart, Germany — [2]Material Science Division, Argonne National Laboratory, Argonne, Illinois 60439-4831, U.S.A.

The quasi-two-dimensional organic superconductor β'' – $(ET)_2SF_5CH_2CF_2SO_3$ is a prominent example of highly correlated electron systems. It raises interest because it forms a density-wave state around 140 K proposed by [Nam et al., PRL **87**, 117001]. Previous optical measurements do not show a Drude contribution. Here we present reflectance measurements at frequencies down to 10 cm^{-1} and temperatures down to 1.8 K, well below the superconducting transition $T_c = 5.2$ K. Already at room temperature a Drude behavior is observed which grows for lower temperatures. For light polarized in the high reflecting direction a pronounced gap opens around 200 cm^{-1} for $T < 125$ K. This we relate to the density-wave-gap driven by the nesting of the quasi-one-dimensional Fermi surface. The gap shows a slight anisotropy.

TT 22.4 Thu 10:15 H18

Quadratic temperature dependence of the resistivity up to 50 K of transition metal dichalcogenides with distorted CdI_2-structure — •Thorsten Zandt, Helmut Dwelk, Christoph Janowitz, and Recardo Manzke — Institut für Physik, Humboldt-Universität zu Berlin, Newtonstraße 15, 12489 Berlin

In this contribution we present a detailed study of the temperature dependence of the electrical resistivity and magnetoresistance of β/Td-$MoTe_2$, WTe_2, $NbTe_2$ and $TaTe_2$ single crystals between 1.7 K and 350 K. In particular, the electrical resistivity, R(T)-R(0), shows at low temperatures a gradient proportional to T^2 up to 50 K what is atypical for 'normal' metallic behavior. In contrast, the magnetoresistance shows a normal characteristics for a metal. These results will be discussed within the framework of several microscopic mechanisms, e.g. like electron-electron scattering, which include electron-electron, hole-hole, and electron-hole processes [1].

[1] T. Zandt, H. Dwelk, C. Janowitz und R. Manzke: Quadratic temperature dependence of the resistivity up to 50 K of metallic $MoTe_2$, proceedings of the 15th International Conference on Solid Compounds of Transition Elements Krakau 2006, will be published 2007 in the Journal of Alloys and Compounds

TT 22.5 Thu 10:30 H18

Quasi one-dimensional magnetism driven by unusual orbital ordering in $CuSb_2O_6$ — •Helge Rosner[1], Deepa Kasinathan[1], and Klaus Koepernik[1,2] — [1]MPI CPfS Dresden, Germany — [2]IFW Dresden, Germany

Cuprate compounds, including the family of high-T_c-superconductors, exhibit a large variety of exotic physical properties. This variety is determined by the interplay of different interactions; mainly covalency, ligand-fields and strong correlation effects. A nearly universal component of cuprate systems is a strongly elongated CuO_6-octahedron wherein the exotic behaviour finds its origin in the deceivingly simple planar Cu-O orbital lying in its basal plane. In this well established standard scenario, the involvement of the apical out-of-plane orbitals is not settled completely. The surprisingly regular CuO_6-octahedra of $CuSb_2O_6$ offer a unique opportunity to elucidate this scenario due to the changed balance of interactions in this system. Here, we present an electronic structure study resulting in an hitherto unobserved ground state originating from a competition of in- and out-of-plane orbitals. Our results show that strong Coulomb correlation drives a surprising and unique orbital ordering. This, in turn, gives rise to an unusual and strongly one-dimensional magnetic ordering that is unlike any ordering observed in conventional low-dimensional cuprates. Our results provide a unique and natural interpretation of recent neutron data and indicate a rare opportunity to study the involvement of non-planar orbital effects.

The Emmy-Noether program is acknowledged for financial support.

TT 22.6 Thu 10:45 H18

Correlation driven charge order at $LaAlO_3/SrTiO_3$ and $LaTiO_3/SrTiO_3$ Interfaces — •Rossitza Pentcheva[1] and Warren Pickett[2] — [1]Section Crystallography, Dept. of Earth and Envi-

ronmental — [2]Department of Physics, University of California, Davis,

To explain recent experiments reporting metallic conductivity at the interfaces between the Mott insulator $LaTiO_3$ (LTO) and band insulator $SrTiO_3$ (STO) but also between the two simple band insulators $LaAlO_3$ (LAO) and STO we have performed density-functional theory calculations employing the FP-LAPW-method within the WIEN2k implementation including a Hubbard-type on site Coulomb repulsion (DFT+U). We find that charge mismatch at the LTO/STO IF is accommodated by the formation of a charge and orbitally ordered (CO/OO) layer with a checkerboard arrangement of Ti^{3+} and Ti^{4+} and an antiferromagnetic coupling of the Ti^{3+}-spins [1]. Lattice relaxations lead to the observed conducting behavior. An analogous diluted layer of Ti^{3+} spins is obtained for the *n*-type LAO/STO interface, although the corresponding bulk materials are nonmagnetic [2]. For a structurally ideal *p*-type LAO/STO IF strong correlations in the oxygen *p* states and the formation of a charge and orbitally ordered O Pπ magnetic hole render a possible explanation for the measured insulating behavior. Alternatively, charge compensation by oxygen vacancies and the formation of a charge conjugate F-center is considered.

[1] R. Pentcheva and W.E. Pickett, cond-mat/0608212.
[2] R. Pentcheva and W.E. Pickett, Phys. Rev. B. 74, 035112 (2006).

TT 22.7 Thu 11:00 H18

Optical properties of the 1D antiferromagnet $KCuF_3$ — •Joachim Deisenhofer[1], Paolo Ghigna[2], Franz Mayr[3], Alois Loidl[3], and Dirk van der Marel[1] — [1]Departement de Physique de la Matiere Condensee, Universite de Geneve, CH-1211 Geneve 4, Switzerland, — [2]Dipartimento di Chimica Fisica, Universita di Pavia, I-27100 Pavia, Italy, — [3]Experimentalphysik V, Center for Electronic Correlations and Magnetism, Augsburg University, D-86135 Augsburg, Germany

We present measurements of the optical properties of $KCuF_3$, a paradigm for orbital ordering[1] and one of the best realizations of a quasi-one dimensional spin chain [2]. We can identify the d-d excitations on the Cu sites and the charge-transfer gap of the system. The observed level splitting and the gap value will be compared to recent results obtained by LDA+U calculations [3]. Moreover, we find anomalies in the optical properties already above the magnetic phase transition. These features appear concomitantly with a change in the orbital order parameter as reported by resonant x-ray scattering [4] and evidence a low-temperture structural change [5].

[1] K. I. Kugel and D. I. Khomskii, Sov. Phys. Usp. 25, 231 (1982). [2] B. Lake et al., Nature Materials 4, 329 (2005). [3] I. Leonov, unpublished. [4] L. Paolasini et al., PRL 88, 106403 (2002). [5] N. Binggeli and M. Altarelli, PRB 70, 085117 (2004).

15 min. break

TT 22.8 Thu 11:30 H18

Orbital Ordering in Cs_2AgF_4 - an electronic structure study — •Deepa Kasinathan[1], Klaus Koepernik[1,2], and Helge Rosner[1] — [1]Max Planck Institute for Chemical Physics of Solids, Dresden, Germany — [2]IFW Dresden, P.O. Box 270016, D-01171, Germany

The argentate Cs_2AgF_4, first synthesized in 1974 has many similarities to the high-T_c cuprates, featuring AgF_2 sheets in place of CuO_2 sheets. While the undoped cuprates are antiferromagnetic, this argentate is ferromagnetic with a T_{Curie} of about 15 K. Density functional calculations in the proposed tetragonal structure produce an itenerant half-metallic ferromagnet. Recent inelastic neutron scattering experiments have suggested an orthorhombic structure that allows an orbitally ordered ferromagnetic ground state. We performed electronic structure calculations using the LDA+U method on this system and were able to obtain an orbitally ordered ground state, not only for the newly proposed orthorhombic lattice but also for the orginal tetragonal lattice by constraining the bravais lattice and allowing the change of the atomic basis. In specific, very small changes in the position of the in-plane fluorine atoms already trigger an orbital ordering. Our calculated energy scale shows that this orbitally ordered state should be stable for all temperatures, consistent with the experiment.

TT 22.9 Thu 11:45 H18

Evidence for a magnetic phase transition in the frustrated spin-1/2 Heisenberg chain compound Li_2ZrCuO_4 — •Natalia Tristan[1], Rüdiger Klingeler[1], Hubertus Luetkens[2], Hans-Henning Klauss[3], Stefan-Ludwig Drechsler[1], Yuri Skourski[4], Olga Volkova[5], Alexander Vasiliev[5], Bernd Büchner[1], and N. Leps[1] — [1]Leibniz-Institute for Solid State and MaterialsResearch, IFW-Dresden, 01171 Dresden, Germany — [2]Laboratory for Muon-Spin Spectroscopy, PaulScherrer Institut, CH-5232 Villigen, Switzerland — [3]Institute for Physics of Condensed Matter,Technical University Braunschweig, Germany — [4]HighMagnetic Field Laboratory, FZ Dresden-Rossendorf, Germany — [5]Physics Faculty, Moscow State University,Russia

The anomaly of unusual shape in the specific heat and the maximum in the derivative of the magnetic suseptibility $d\chi(T)/dT$ at around 6 K as well as magnetization behavior of the low dimensional Li_2ZrCuO_4 allude to onset of a long range order in this compound. This suggestion is also supported by results of muon spin relaxation performed on a powder sample of Li_2ZrCuO_4, which show a spontaneous muon spin precession below 5.75 K. A peculiar rectangular shape of the static field distribution in the ordered state is consistent with an incommensurate helical spin structure predicted theoretically.

TT 22.10 Thu 12:00 H18

The electronic structure of the quantum critical system Li_2ZrCuO_4 — •Miriam Schmitt[1], Jiři Málek[2,3], Stefan-Ludwig Drechsler[2], and Helge Rosner[1] — [1]MPI CPfS Dresden — [2]IFW Dresden — [3]Institute of Physics, ASCR, Praha, Czech Republic

Quasi one-dimensional magnetic chain compounds with nearest-neighbor exchange J_1 and next-nearest-neighbor exchange J_2 exhibit a quantum critical point (QCP) for the ratio J_2/J_1 = -0.25. The recently synthesized compound Li_2ZrCuO_4, which contains spin-1/2 chains of distorted, edge shared CuO_4 plaquettes, is close to this QCP and shows therefore a strong field dependence of the thermodynamical properties. From fits to the measured susceptibility and specific heat, a ratio $J_2/J_1 \sim$ -0.3 was determined.[1] Here, we present a detailed study of the electronic and magnetic properties of Li_2ZrCuO_4 based on density functional calculations. We combine results of LDA calculation, which were mapped onto an effective one-band tight-binding model and subsequently to an extended Heisenberg model with exchange integrals derived from total energy differences for constraint magnetic states using LDA+U. The influence of (i) the deviation from the standard, planar CuO_4 geometry and (ii) the experimentally observed Li disorder was carefully investigated. We find $J_2/J_1 \sim -0.25 \pm 0.03$ very close to the QCP. In addition, we obtain a sizeable inter-chain coupling $J_\perp \sim$ 7K playing an important role for the saturation field due to the vicinity of the QCP.

The Emmy-Noether program is acknowledged for financial support.

[1] S.-L. Drechsler *et al.* Phys. Rev. Lett., accepted.

TT 22.11 Thu 12:15 H18

Magnetic frustration in one dimension - the distorted diamond chain azurite($Cu_3(CO_3)_2(OH)_2$) - — •Bernd Wolf[1], Andreas Brühl[1], Mariano de Souza[1], Katharina Removic-Langer[1], Yeekin Tsui[1], Ulrich Tutsch[1], Jürgen Schreuer[2], and Michael Lang[1] — [1]Physikalisches Institut, Universität Frankfurt, 60438 Max-von-Laue-Strasse 1, FOR 412 — [2]Institut für Mineralogie, Ruhr-Universität-Bochum, 44780 Universitätsstrasse 150

A simple realization of a frustrated quantum-spin system is the S = 1/2 distorted diamond chain, where the ground state is strongly constrained by the ratio of the three coupling constants J_i. A theoretical phase diagram at T = 0 was examined consisting of a ferrimagnetic -, a dimerized -, as well as a spin fluid (SF) phase. The natural mineral azurite ($Cu_3(CO_3)_2(OH)_2$) represents a distorted diamond chain. We discuss thermodynamic measurements, such as specific heat, thermal expansion, elastic constant and magnetic susceptibility, some of which are also measured under hydrostatic pressure, in a wide-stretched temperature and field range. According to magnetic susceptibility and magnetization measurements, the ground state of azurite is located close to the quantum phase transition, separating the gapless SF phase from the gapped dimerized phase. We find pronounced acoustic anomalies at high fields indicating a significant spin-phonon interaction. From the enormous size of the anomalies in the sound velocity, a large magnetic Grüneisen parameter can be inferred, this possibly resulting from the proximity of the system to a quantum critical point.

TT 22.12 Thu 12:30 H18

Optical response of the ladder compound $Sr_{2.5}Ca_{11.5}Cu_{24}O_{41}$ under high pressure — •S. Frank[1], C. A. Kuntscher[1], R. Klingeler[2], and B. Büchner[2] — [1]Experimentalphysik II, Universität Augsburg, D-86159 Augsburg, Germany — [2]Leibniz-Institut für Festkörper-und Werkstoffforschung Dresden, PF 27 01 16, 01171 Dres-

den, Germany

Since the discovery of a pressure-induced superconducting phase, the highly Ca-doped $Sr_{14-x}Ca_xCu_{24}O_{41}$ two-leg ladder compound is intensively investigated. Based on earlier studies it was suggested that Ca doping [1,2] as well as the application of pressure [3] transfer holes from the chains to the ladders. The nature of the superconductivity, however, remains an open issue.

An important piece of information is how the dynamics of the charge carriers change upon pressure application. We therefore studied the pressure-dependent optical response of $Sr_{2.5}Ca_{11.5}Cu_{24}O_{41}$ over a broad frequency range (far-infrared to visible) at room temperature. Based on these results, we will discuss the possible occurrence of a pressure-induced dimensional crossover in $Sr_{2.5}Ca_{11.5}Cu_{24}O_{41}$ and speculate on the implications of our findings for the superconductivity in this system. *Supported by the DFG, Emmy Noether-program. Provision of beamtime at the ANKA Angströmquelle Karlsruhe is acknowledged.*

[1] T.Osafune et al., Phys. Rev. Lett. **78**, 1980 (1997)
[2] N. Nücker et al., Phys. Rev. B **62**, 14384 (2000)
[3] Y.Piskunov et al., Phys. Rev. B **72**, 064512 (2006)

TT 22.13 Thu 12:45 H18

$CuSe_2O_5$ – a new quasi one-dimensional spin-1/2 Heisenberg system — •Oleg Janson[1,2], Walter Schnelle[1], Marcus Schmidt[1], Stefan-Ludwig Drechsler[3], and Helge Rosner[1] — [1]MPI CPfS Dresden, Germany — [2]St. Petersburg State University, Russia — [3]IFW Dresden, Germany

We report a joined experimental and theoretical study of the new quasi one-dimensional spin-1/2 Heisenberg system $CuSe_2O_5$. Its crystal structure is characterized by chains of canted isolated CuO_4 plaquettes aligned along the c axis of the monoclinic lattice, raising the question about the size of the different exchange couplings between the CuO_4 units. Combining measurements of the magnetic susceptibility χ and specific heat c_p with DFT band structure calculations, we analyze the magnetic properties and the leading exchange interactions of this compound. The single crystals of $CuSe_2O_5$ were grown by chemical vapour transport using $TeCl_4$ as transport agent. Our χ and c_p data indicate a phase transition to long range antiferromagnetic order at $T_N \sim 17$K. From a tight-binding analysis of the electronic structure and from total energy calculations for constraint magnetic states we can describe the system in good approximation by a nearest neighbour exchange $J_1 \sim 20$ meV along the structural chains and a sizable interchain coupling $J_\perp \sim 5$ meV in good agreement with the experimental results.
The Emmy-Noether program is acknowledged for financial support.

TT 23: Nanoelectronics II - Spintronics and Magnetotransport

Time: Thursday 9:30–12:30 Location: H19

TT 23.1 Thu 9:30 H19

Spin-density in a two-dimensional electron gas induced by an electromagnetic wave — •Alexander Shnirman[1] and Ivar Martin[2] — [1]Institut für Theoretische Festkörperphysik, Universität Karlsruhe, D-76128 Karlsruhe, Germany. — [2]Theoretical Division, Los Alamos National Laboratory, Los Alamos, NM 87545, USA.

We consider the magnetic response of a two-dimensional electron gas (2DEG) with a spin-orbit interaction to a long-wave-length electromagnetic excitation. We observe that the transverse electric field creates a spin polarization perpendicular to the 2DEG plane. The effect is more prominent in clean systems with resolved spin-orbit-split subbands, and reaches maximum when the frequency of the wave matches the subband splitting at the Fermi momentum. The relation of this effect to the spin-Hall effect is discussed.

TT 23.2 Thu 9:45 H19

Combining Ferroelectricity, Magnetism, and Superconductivity in Tunnel Junctions — •Hermann Kohlstedt[1], Nicholas Pertsev[1,2], Adrian Petraru[1], Ulrich Poppe[1], and Rainer Waser[1] — [1]Institut für Festkörperforschung and CNI, Forschungszentrum Jülich, Jülich, Germany — [2]A. F. Ioffe Physico-Technical Institute, St. Petersburg, Russia

Complex oxides display a rich variety of physical phenomena including magnetism, superconductivity, and ferroelectricity. First, we will present our theoretical and experimental results on the so-called ferroelectric tunnel junctions (FTJs). These junctions consist, e.g., of $SrRuO_3/BaTiO_3/SrRuO_3$ trilayers grown on $SrTiO_3$ by high-pressure sputtering. The heterostructures were investigated by means of x-ray diffraction to determine crystallographic structure and lattice strains. Then the electrical properties of FTJs were determined by resistive transport measurements and by recording the polarization-voltage hysteresis loops. Size effects observed in ultra-thin ferroelectric films will be discussed, as well as the theoretical models of the interplay between electron tunneling and polarization state of the barrier. Second, we will provide an overview for the current status of the international studies of the so-called multiferroic tunnel junctions. By combing ferroelectric or multiferroic tunnel barriers with ferromagnetic and/or superconducting electrodes, a whole *zoo* of novel tunnel junctions can be proposed. The results already obtained for these new types of tunnel junctions and the theoretical and experimental challenges existing in this area will be discussed.

TT 23.3 Thu 10:00 H19

EuO_{1-x} - Ein vielseitiger, ferromagnetischer Halbleiter für Silizium-basierte Spintronik — •A. Schmehl[1], S. Thiel[1], J. Mannhart[1], V. Vaithyanathan[2], D. G. Schlom[2], L. Fitting[3], D. A. Muller[3], Y. Barash[4], T. Heeg[5], J. Schubert[5], M. Liberati[6] und Y. Idzerda[6] — [1]Universität Augsburg — [2]Penn State University, USA — [3]Cornell University, USA — [4]Russian Academy of Sciences, Chernogolovka, Russland — [5]Forschungszentrum Jülich — [6]Montana State University, USA

Halbmetallische EuO_{1-x}-Filme wurden epitaktisch auf Si gewachsen. Diese Schichten zeigen außergewöhnlich starke magnetoresistive Effekte (CMR) und ausgeprägte Metall-Isolator-Übergänge (MIT). SQUID Messungen bei 5 K ergeben Sättigungsmagnetisierungen von $6.7\,\mu_B$/Eu, nahe der theoretischen Voraussage von $7\,\mu_B$/Eu. Die Filme zeigen MITs mit Widerstandsänderungen von bis zu acht Größenordnungen. Externe Magnetfelder induzieren ausgeprägte CMR Effekte, mit bis zu fünf Größenordnungen Widerstandsänderung für 8 T nahe dem Nullfeld-T_C. Andreev-Reflektions-Mesungen an 0.5% La-dotierten EuO_{1-x}-Filmen zeigen Spinpolarisationen der Leitungselektronen im ferromagnetischen Zustand von über 90%. Dies demonstriert den halbmetallischen Charakter der $Eu_{1-y}La_yO_{1-x}$-Schichten. Durch die hervorragende elektronische Kompabilität von EuO_{1-x} und Si, zusammen mit den großen Spin-Dekohärenzzeiten und Längen von Leitungselektronen in Silizium, haben daher EuO_{1-x}/Si-Heterostrukturen ein großes Potential für die Entwicklung Si-basierter Spintronik.

TT 23.4 Thu 10:15 H19

Electric Dipole Induced Spin Resonance in Quantum Dots — Vitaly Golovach, •Massoud Borhani, and Daniel Loss — Department of Physics, University of Basel, Switzerland

An alternating electric field, applied to a "spin 1/2" quantum dot, couples to the electron spin via the spin-orbit interaction. We analyze different types of spin-orbit couplings known in the literature and find that an electric dipole spin resonance (EDSR) scheme for spin manipulation can be realized with the up-to-date experimental setups. In particular, for the Rashba and Dresselhaus spin-orbit couplings, a fully transverse effective magnetic field arises in the presence of a Zeeman splitting in the lowest order of spin-orbit interaction. Spin manipulation and measurement of the spin decoherence time T_2 are straightforward in lateral GaAs quantum dots through the use of EDSR.

TT 23.5 Thu 10:30 H19

Crossover from diffusive to non-diffusive dynamics in the two-dimensional electron gas with Rashba spin-orbit coupling — •Mikhail Pletyukhov — Institut für Theoretische Festkörperphysik, Universität Karlsruhe, D-76128 Karlsruhe, Germany

We present the calculation of the density matrix response function of the two-dimensional electron gas with Rashba spin-orbit interaction characterized by the coupling constant α_R, which is applicable

in a wide range of parameters covering the diffusive ($v_F q, \omega \ll \tau^{-1}$) and non-diffusive ($v_F q, \omega \gg \tau^{-1}$), the dirty ($\alpha_R k_F \ll \tau^{-1}$) and the clean ($\alpha_R k_F \gg \tau^{-1}$) limits. A description of the crossover between the different regimes is thus provided as well. On the basis of the derived microscopic expressions we study the propagating charge and spin-polarization modes in the clean, non-diffusive regime, which is achievable in the modern experiments.

TT 23.6 Thu 10:45 H19

Spin transport in Heisenberg antiferromagnets — •Michael Sentef, Marcus Kollar, and Arno Kampf — Theoretische Physik III, Elektronische Korrelationen und Magnetismus, Institut für Physik, Universität Augsburg, 86135 Augsburg, Germany

We study the dynamic spin conductivity of insulating antiferromagnets described by the XXZ Heisenberg model in two and three dimensions. Spin currents flow in response to a magnetic-field gradient or, in systems with spin-orbit coupling, perpendicular to a time-dependent electric field. Linear response theory provides the Kubo formula for the spin conductivity, which is then calculated within interacting spin-wave theory. We find that the dimensionality of the system plays a crucial role for the isotropic Heisenberg model: In $d = 3$ the regular part of the spin conductivity vanishes linearly in the zero frequency limit, whereas in $d = 2$ it approaches a finite zero frequency value.

[1] M. Sentef, M. Kollar, and A. P. Kampf, cond-mat/0612215 (2006).

15 min. break

TT 23.7 Thu 11:15 H19

Resonant spin polarization and spin current in a two-dimensional electron gas — •Mathias Duckheim and Daniel Loss — Department of Physics and Astronomy, University of Basel, CH-4056 Basel, Switzerland

A versatile scheme of spin control is electric dipole spin resonance (EDSR) where the radio-frequency fields driving the spins are electric[1], and not magnetic like in standard paramagnetic resonance. We present a theoretical study of EDSR in a disordered two-dimensional electron gas. We show that a very high spin polarization can be achieved in a sample where both Rashba and Dresselhaus spin orbit interactions are present rendering the spin splitting anisotropic. By choosing a particular geometry in a strong magnetic field the anisotropy of the spin splitting can be optimally exploited leading to a substantial enhancement of the spin susceptibility. Moreover, the generated spin polarization is intrinsically linked with an ac spin Hall current. The corresponding spin Hall conductivity displays a universal behavior in the high frequency limit and vanishes when the spin susceptibility is maximal. We show that the spin Hall current can be interpreted in terms of geometrical properties of the spin polarization.

[1] M. Duckheim and D. Loss, Nature Physics **2**, 195 (2006)

TT 23.8 Thu 11:30 H19

Zeeman ratchets: rectification of spin currents via magnetic fields — •Matthias Scheid[1], Dario Bercioux[1,2], and Klaus Richter[1] — [1]Institut für theoretische Physik, Unversität Regensburg, Germany — [2]Physikalisches Institut, Albert-Ludwigs-Universistät, Freiburg, Germany

We propose devices creating directed spin-polarized currents in a two-dimensional electron gas (2DEG) subject to a spatially varying magnetic field [1] and an external adiabatic driving. We consider ballistic, coherent transport through quantum confined systems, where the spatially dependent Zeeman term in the Hamiltonian gives rise to spin polarized currents inside the 2DEG. We explore several setups of these spin ratchets [2], which give rise to nonzero averaged net spin currents in the absence of net charge transport.

[1] A. Matulis, F. M. Peeters, and P. Vasilopoulos, Phys. Rev. Lett. **72**, 1518 (1994).

[2] M. Scheid, M. Wimmer, D. Bercioux, and K. Richter, phys. stat. sol. (c), in print (2006), cond-mat/0607380.

TT 23.9 Thu 11:45 H19

Universality in Voltage-driven Nonequilibrium Phase Transitions — •Michael Arnold and Johann Kroha — Physikalisches Institut, Nussallee 12, 53115 Bonn

We consider the non-equilibrium ferromagnetic transition of a mesoscopic sample of a resistive Stoner ferromagnet coupled to two paramagnetic leads. The transition is controlled by either the lead temperature T or the transport voltage V applied between the leads. We calculate the temperature and voltage dependence of the magnetization. In the particle hole symmetric case we find within mean-field theory that even at finite bias the magnetization does not depend on the position along the sample axis, although the charge density and other quantities do vary. This may be relevant for possible spintronics applications. In addition, we establish a generalized control parameter in terms of T and V which allows for a universal description of the temperature- and voltage-driven transition.

TT 23.10 Thu 12:00 H19

Theoretical study of the conductance of ferromagnetic atomic-sized contacts — •M. Häfner[1,2], J. Viljas[1,2], D. Frustaglia[3], F. Pauly[1,2], M. Dreher[4], P. Nielaba[4], and J. C. Cuevas[5,1,2] — [1]Institut für Theoretische Festkörperphysik, Universität Karlsruhe, D-76128 Karlsruhe — [2]FZ Karlsruhe, Institut für Nanotechnologie, D-76021 Karlsruhe — [3]NEST-CNR-INFM & SNS, I-56126 Pisa — [4]Fachbereich Physik, Universität Konstanz, D-78457 Konstanz — [5]Universidad Autónoma de Madrid, E-28049 Madrid

Different experiments on the transport through atomic-sized contacts made of ferromagnetic materials have produced contradictory results such as the observation of half-integer conductance quantization. We have studied theoretically the conductance of ideal atomic contact geometries of the ferromagnetic $3d$ materials Fe, Co, and Ni using a realistic tight-binding model. Our analysis [1] shows that in the absence of magnetic domains, the d bands of these transition metals play a key role in the electrical conduction. In the contact regime this fact leads to the following consequences: (i) there are partially open conduction channels and therefore conductance quantization is not expected, (ii) the conductance of the last plateau is typically above $G_0 = 2e^2/h$, (iii) both spin species contribute to the transport and thus there is in general no full current polarization, and (iv) both the value of the conductance and the current polarization are very sensitive to the contact geometry and to disorder. In the tunneling regime we find that a strong current polarization can be achieved.

[1] M. Häfner et al., cond-mat/0608132

TT 23.11 Thu 12:15 H19

Electron transport in quantum dots in the spin blockade regime — Carlos Lopez-Monis[1], Maria Busl[1,2], Jesus Inarrea[1,3], Gianaurelio Cuniberti[2], and •Gloria Platero[1] — [1]ICMM, CSIC, Cantoblanco, E-28049 Madrid — [2]Institut für Theoretische Physik, Universität Regensburg, D-93040 Regensburg — [3]Escuela Politecnica Superior, Universidad Carlos III, E-28911 Madrid

Recent experiments of transport through two weakly coupled quantum dots [1] show finite currents in the spin blockade region which is attributed to the hyperfine interaction between electronic and spin nuclei. We analyze the electronic spin transport through different quantum dot configurations in the regime where spin blockade occurs. We include in our description phonon-mediated hyperfine interaction between the electron and spin nuclei through the Overhauser effect, as the main source of spin-flip. Our model consists on rate equations for the electronic states occupations and nuclei spin polarizations which are treated in a self-consistent way [2]. We discuss the current as a function of an external magnetic field, where singlet and triplet inter-dot state crossings occur.

[1] K. Ono et al., Science 297 1313 (2002); K. Ono et al., Phys. Rev. Lett. 92, 256803 (2004).

[2] J. Inarrea et al., cond-mat/0609323; J. Inarrea et al., Physica Status Solidi (a), 203, 6 1148 (2006).

TT 24: Symposium "Condensed Matter Phases in Ultracold Atoms"

Time: Thursday 9:30–12:50 Location: H20

Invited Talk TT 24.1 Thu 9:30 H20

Probing interacting systems of cold atoms using interference experiments — •Eugene Demler — Harvard University, Cambridge, MA 02138, USA

This talk will review how interference experiments can be used to analyze equilibrium and non-equilibrium phenomena in interacting systems of cold atoms. This includes analysis of correlation functions based on measuring interference amplitude for independent condensates and analysis of phase dynamics in coupled condensates.

Invited Talk TT 24.2 Thu 10:00 H20

Criticality and correlations in cold atomic gases — •Michael Köhl — University of Cambridge, Department of Physics, J J Thomson Avenue, Cambridge CB3 0HE, UK — ETH Zürich, Institute of Quantum Electronics, 8093 Zürich, Switzerland

Phase transitions are among the most dramatic phenomena in nature. Minute variations in the conditions controlling a system trigger a fundamental change of its properties. In the critical regime near a second-order phase transition point the fluctuations of the order parameter are so dominant that they completely govern the behavior of the system on all length scales. Using cold atomic gases, we have directly observed critical fluctuations of the order parameter near the phase transition of Bose-Einstein condensation. From the divergence of the correlation length versus temperature we have determined its critical exponent ν. Despite our densities being nine orders of magnitude smaller and our interactions considerably weaker, we find a remarkable similarity to case of the λ-transition of Helium-4.

TT 24.3 Thu 10:30 H20

Bose gas in Flatland — •Zoran Hadzibabic, Peter Kruger, Marc Cheneau, Baptiste Battelier, Patrick Rath, and Jean Dalibard — Laboratoire Kastler Brossel, 24 Rue Lhomond, 75005 Paris, France

Physics of a Bose gas in 2D is quite different from the usual 3D situation. In a homogeneous 2D fluid of identical bosons long-range order is always destroyed by long wavelength thermal fluctuations, but the system can nevertheless become superfluid at a finite critical temperature. This phase transition does not involve any symmetry breaking and in the Berezinskii-Kosterlitz-Thouless (BKT) paradigm it is explained in terms of binding and unbinding of pairs of vortices with opposite circulations. Above the critical temperature, proliferation of unbound vortices is expected.

Using optical lattice potentials we can create two parallel, independent 2D atomic clouds with similar temperatures and chemical potentials. When the clouds are suddenly released from the trapping potential and allowed to freely expand, they overlap and interfere. This realizes a matter wave heterodyning experiment which gives direct access to several features of the phase distributions in the two planes. Long wavelength phase fluctuations create a smooth and random variation of the interference fringes and free vortices appear as sharp dislocations in the interference pattern. Temperature study of these effects supports the BKT picture of the development of quasi-long-range coherence in these systems.

15 min. break

TT 24.4 Thu 11:10 H20

Simulations of ultra-cold atom gases on frustrated optical lattices — •Stefan Wessel — Institut für Theoretische Physik III, Universität Stuttgart

We review results from recent quantum Monte Carlo simulations of ultra-cold bosonic atoms on frustrated optical lattices such as the triangular and the Kagome lattice. For the triangular lattice case a supersolid state of matter emerges, resulting from a novel order-by-disorder effect in the strongly interacting regime. On the Kagome lattice the atoms form exotic valence-bond-solids with local bosonic resonances. We discuss the quantum melting transitions of these solids, the connection to the recently proposed deconfined quantum criticality scenario, as well as the relation to frustrated quantum magnetism.

TT 24.5 Thu 11:35 H20

Multicolor Hubbard models with ultracold atoms — •Carsten Honerkamp — Universität Würzburg, Am Hubland, D-97074 Würzburg

In ultracold atomic systems, the hyperfine states provide an internal degree of freedom which may allow for the realization of novel many-particle states without obvious ancestors in solid state physics. Here we review our results (most recent: A. Rapp, G. Zarand, C. Honerkamp, W. Hofstetter, cond-mat/0607138) on fermionic SU(N)-Hubbard models on optical lattices where N denotes the number of hyperfine states (colors) loaded into the lattice. In the case of repulsive interactions on the half-filled square lattice, staggered current phases replace generalized antiferromagnetic ordering above a critical color number. For the attractive case we focus on $N = 3$, as this can be possibly realized using ^{6}Li. For weak attractions and generic densities, the variational ground-state is a color-superfluid with an ungapped branch of single-particle excitations. For increasing attraction, an extended variational ansatz reveals a continuous quantum phase transition toward a color-confining heavy-fermion phase with bound states of three particles, mimicking the QCD phase transition a high matter density. For low densities in our lattice model, this transition can be interpreted in simple two-fluid model.

TT 24.6 Thu 12:00 H20

Fermionic Superfluidity with Imbalanced Spin Populations — •Martin Zwierlein — MIT, Cambridge, MA, USA — Johannes-Gutenberg Universität Mainz, Germany

Whether it occurs in superconductors, helium-3 or inside a neutron star, fermionic superfluidity requires pairing of fermions. For an equal mixture of spin up and spin down fermions, pairing can be complete and the entire system will become superfluid. If the two fermion populations are imbalanced, not every particle can find a partner. Will the system nevertheless stay superfluid?

In this talk I will present our studies of this intriguing question in an unequal mixture of strongly interacting, ultracold fermionic atoms. We establish the phase diagram for the superfluid and the normal state as a function of population imbalance and interaction strength. Due to strong interactions near a Feshbach resonance, the superfluid state is remarkably stable in response to population imbalance. The final breakdown of superfluidity at large imbalance marks a phase transition, the Pauli or Clogston limit of superfluidity.

TT 24.7 Thu 12:25 H20

Vortex Matter in Optical Lattices — •Michiel Snoek — Institut für Theoretische Physik, Universität Frankfurt, Frankfurt am Main, Deutschland

A Bose-Einstein condensate responds to rotation by forming quantized vortices. The quantum fluctuations of these vortices are greatly enhanced by slicing the Bose-Einstein condensate into a stack of two-dimensional pancake-condensates by means of an optical lattice.

A single vortex line in this setup has bosonic fluctuations and is equivalent to a bosonic string. By trapping fermionic atoms in the vortex cores, a superstring can be realized.

Multiple vortex lines order in a Abrikosov lattice. We have investigated the excitations of the vortex lattice; in particular we studied the Bloch bands of the Tkachenko modes. Vortex fluctuations melt the vortex crystal after which higly correlated quantum liquids are formed. Because of the small number of particles in the pancake Bose-Einstein condensates at every site of the optical lattice, finite-size effects and effects of the inhomogeneous density are important. As a result, the melting of the lattice occurs from the outside inwards. We studied the melting of the vortex lattice as a function of rotation frequency, temperature, and strength of the optical lattice.

TT 25: Quantum Liquids, Bose-Einstein Condensates, Ultracold Atoms, ...

Time: Thursday 14:00–15:45 Location: H18

TT 25.1 Thu 14:00 H18

From superfluidity to Anderson-localization in quasi 1d Bose-Einstein condensates. — •Tobias Paul, Patricio Leboeuf, and Nicolas Pavloff — Laboratoire de Physique Théorique et Modèles Statistiques, Universite Paris Sud, Batiment 100, F-91405 Orsay Cedex

The interplay between particle-particle interactions and disorder-induced interference effects is a challenging aspect of condensed matter physics, which is due to the advent of coherent atom manipulation nowadays revisited in guided Bose-Einstein condensates [1,2]. In this contribution we present a new, global analysis of the coherent condensate flow through a disordered region. We show that a variation of the condensate velocity v with respect to the disordered potential induces different regimes of quantum transport. We demonstrate the existence of three different regimes: At velocities v small compared to the sound velocity c the flow shows superfluid behaviour, whereas a domain of time dependent flow is reached when v becomes comparable to c. For velocities v considerably larger then the sound velocity again a stationary regime is found. In this domain, depending of the extent of the disordered region, the system enters an Anderson localized phase.

[1] D. Clement *et al.* Phys. Rev. Lett. **95**, 170409 (2005)
[2] T. Schulte *et al.* Phys. Rev. Lett. **95**, 170411 (2005)

TT 25.2 Thu 14:15 H18

Glassy behavior of Bose-Bose mixtures in one-dimensional optical lattices — •Tommaso Roscilde and Juan Ignacio Cirac — Max-Planck-Institut fuer Quantenoptik, Gaching b. Muenchen

We numerically investigate the properties of strongly repulsive two-boson mixtures in one-dimensional optical lattices, targeting their ground state either by slow cooling from high temperature, or by a slow change in the Hamiltonian parameters starting from the weakly interacting regime. The two bosonic species have very different effective masses, so that the slow bosons can act as an effective potential to the faster ones. When the interspecies repulsion is strong compared with the intraspecies one, a phase-separated ground state is masked by an exponentially large number of metastable *quantum emulsion* states, in which the two species are fragmented into microscopic droplets. The quantum emulsion states can be regarded as the out-of-equilibrium realization of a localization phenomenon, in which each species acts as a random potential to the other one, effectively localizing it. Quantum Monte Carlo investigations reveal an extremely slow relaxation of the system towards equilibrium, typical of a glassy phase. Increasing the intraspecies repulsion for the fast bosons drives them through a quantum phase transition to the superfluid state.

TT 25.3 Thu 14:30 H18

Dynamical mean-field theory for the Bose-Hubbard model — •Krzysztof Byczuk and Dieter Vollhardt — Theoretical Physics III, Center for Electronic Correlations and Magnetism, Institute for Physics, University of Augsburg, D-86135 Augsburg, Germany

The Bose-Hubbard model and Bose-Einstein condensation are investigated on an infinite dimensional lattice. A new way of rescaling the hopping amplitudes is introduced. This leads to a comprehensive theory which is exactly solvable in the limit of infinite dimensions. The solution is given by dynamical mean-field type equations for normal bosons plus an integro-differential Gross-Pitaevski type equation for superfluid bosons coupled to the normal component by dynamical hybridization functions. Local temporal correlations in the normal and superfluid components are treated exactly whereas spatial correlations are absent. All known limiting cases (free gas, atomic limit, Bogoliubov, Bogoliubov-Hartree, and Popov theories) are recovered. Possible strategies to solve this dynamical mean-field theory for correlated bosons are discussed.

TT 25.4 Thu 14:45 H18

Supersolids in confined fermions on one-dimensional optical lattices — •Farshid Karim Pour[1], Marcos Rigol[2], Stefan Wessel[1], and Alejandro Muramatsu[1] — [1]Institut für Theoretische Physik III, Universität Stuttgart, Pfaffenwaldring 57, 70550 Stuttgart, Germany — [2]Department of Physics and Astronomy, University of Southern California Los Angeles, CA 90089, USA

Using quantum Monte Carlo simulations, we show that density-density and pairing correlation functions of the one-dimensional attractive fermionic Hubbard model in a harmonic potential can be characterized by the anomalous dimension K_ρ of a corresponding periodic system. This allows to determine the conditions for a supersolid in a harmonic trap. We show explicitely, that under these conditions the structure form factors for both correlation functions scale with the same exponent as the system size increases, giving rise to a (quasi-) supersolid.

TT 25.5 Thu 15:00 H18

Superfluidity in small 2D trapped systems of charged bosons — •Jens Böning, Alexei Filinov, and Michael Bonitz — Christian-Albrechts Universität Kiel, Institut für Theoretische Physik und Astrophysik, Leibnizstraße 15, 24098 Kiel, Germany

Superfluidity in a trapped cloud of quantum particles is defined using the cloud's response to a rotation of the external potential. The effect is known as the Hess-Fairbank or non classical moment of inertia (NCRI) effect and corresponds to the Meissner effect for superconductivity. It originates from the impossibility to excite vortices in macroscopic systems with an accoustic phonon like energy spectrum and is, thus, inseperably connected to inter-particle interactions. However, due to the discrete nature of the spectrum in trapped finite systems, the NCRI effect can be observed in quantum systems in any case regardless of the presense of interactions. We investigate small bosonic systems in order to distinguish between effects related to a finite system size, inter-particle interactions and quantum statistics. Our results are obtained with first principle path-integral Monte-Carlo (PIMC) simulations [1] and are compared to analytical expressions for the ideal case based on permutations cycles [2], respectively.

[1] Michael Bonitz and Dirk Semkat (eds.): *Introduction to Computational Methods in Many Body Physics*, Rinton Press Inc., 2006
[2] J. Schneider and H. Wallis: *Fully quantum mechanical moment of inertia of a mesoscopic Bose gas* Eur. Phys. J. B **18**, 507–512, 2000

TT 25.6 Thu 15:15 H18

Correlation effects and superfluidity in mass-asymmetric electron-hole bilayers — •Alexei Filinov[1,2], Patrick Ludwig[1], Jens Böning[1], Yurii Lozovik[2], and Michael Bonitz[1] — [1]Institute für Theoretische Physik und Astrophysik, Leibnizstrasse 15, 24098 Kiel — [2]Institute of Spectroscopy RAS, Troitsk, 142190, Russia

We present an overview on path integral Monte Carlo (PIMC) studies of spatially separated electron-hole bilayers [1]. As was recently observed for bulk semiconductors [2], holes undergo a phase transition to a crystalline state if the mass ratio exceeds $M_{cr} \approx 80$. Here, we extend this analysis to bilayers where M_{cr} depends on d and the in-layer particle density. We consider the low density regime when the spin statistics has a negligible effect on the localized states of the holes. With the decrease of d the crystal melts via the formation of indirect excitons. We also find a crystalline state of excitons at lower temperatures. By considering the excitons as a composite bosons we performed PIMC simulations including the exchange effects. The detailed analysis of dependence of the superfluid fraction in mesoscopic systems (two coupled quantum dots) and macroscopic systems are presented. The role of the finite size effects on the condensate fraction and the critical temperature, and deviation from the macroscopic limit, is discussed.

[1] A.Filinov, P.Ludwig, Yu.E.Lozovik, M.Bonitz and H.Stolz, J. Phys: Conf. Series **35**, 197 (2006); Contrib. Plasma Phys., accepted (2007). [2] M.Bonitz, V.S.Filinov, V.E.Fortov. P.R.Levashov, and H.Fehske, J. Phys. A: Math. Gen. **39**, 4717 (2006).

TT 25.7 Thu 15:30 H18

Coherent Matter Waves Emerging from Mott-Insulators — Karen Rodriguez[1], •Salvatore Manmana[1,2,3], Marcos Rigol[4], Reinhard Noack[2], and Alejandro Muramatsu[1] — [1]Institut für Theoretische Physik III, Universität Stuttgart, Pfaffenwaldring 57, D-70550 Stuttgart — [2]AG Vielteilchennumerik, Fachbereich Physik, Philipps-Universität Marburg, D-35032 Marburg — [3]Institute of Theoretical Physics, EPFL, CH-1015 Lausanne (Switzerland) — [4]Physics Department, University of California, Davis, CA 95616 (USA)

Using the adaptive time-dependent density matrix renormalization group method (adaptive t-DMRG), we investigate the non-equilibrium dynamics of a system of strongly interacting soft-core bosons on a one-dimensional lattice modelled by the bosonic Hubbard model. We

study the formation of (quasi-)coherent matter waves emerging from an initial Mott insulator state. It has been shown previously that a quasi-condensate emerges at momentum $k_{\mathrm{cond}} = \pi/2a$, where a is the lattice constant, in the limit of infinitely strong repulsion (hard-core bosons). Here we show that this phenomenon persists for all values of the repulsive interaction that lead to a Mott insulator at a commensurate filling. Different methods for tuning the wave vector of the emerging matter wave are discussed.

TT 26: Metal-Insulator Transition

Time: Thursday 14:00–17:30 Location: H19

TT 26.1 Thu 14:00 H19

Local correlations and hole doping in NiO — •Jan Kunes[1], Vladimir I. Anisimov[2], Alexey V. Lukoyanov[3], and Dieter Vollhardt[1] — [1]Theoretical Physics III, Center for Electronic Correlations and Magnetism, University of Augsburg, Augsburg 86135 — [2]nstitute of Metal Physics, Russian Academy of Sciences - Ural Division, 620041 Yekaterinburg GSP-170, Russia — [3]Ural State Technical University - UPI, 620002 Yekaterinburg, Russia

Charge-transfer (CT) insulators present an important subgroup of transition metal compounds which exhibit phenomena such as metal-insulator transitions or high temperature superconductivity. The location of ligand states between the interaction-split d bands leads to additional complexity, which requires a description beyond a simple Hubbard model. Using a combination of ab initio bandstructure and dynamical mean field theory (DMFT) we study the prototypical CT insulator NiO. Including the ligand p orbitals to the effective Hamiltonian, we obtain good agreement with PES and IPES data. Further we investigate the effect of hole doping. We find the additional holes to occupy mainly the ligand p orbitals despite large Ni-d spectral weight at the top of the valence band. Moreover, heavy hole doping leads to a significant reconstruction of the single-particle spectrum and filling of the charge-transfer gap. This is the first LDA+DMFT study of charge transfer systems, which includes the p-d hybridization explicitly and is thus able to provide a full description of valence and conduction band spectra.

TT 26.2 Thu 14:15 H19

Unusual magnetic ground state in MnO under pressure. — •Klaus Koepernik[1], Deepa Kasinathan[2], and Warren E. Pickett[3] — [1]IFW Dresden, Germany — [2]MPI-CPfS Dresden, Germany — [3]Dept. of Physics, UC Davis, CA, USA

A study of the phase transitions in MnO under pressure is presented. The calculations are based on density functional theory. The onsite correlations in the Mn 3d shell are treated within the framework of LSDA+U. The major result is that the first phase transition (with increasing pressure), which is characterized by an isostructural magnetic moment collapse from spin 5/2 to spin 1/2, results in a low spin solution exhibiting an unexpected intra-atomic spin polarization pattern. An analysis of the influence of the symmetry, the magnetic ordering and the LSDA+U interactions shows that this unusal spin arrangement is the result of inter-orbital exchange terms. The dependence of the results on the parameters U and J will be discussed.

TT 26.3 Thu 14:30 H19

Pressure-induced deconfinement and structural phase transition in the quasi-1D Bechgaard-Fabre salts — •A. Pashkin[1], M. Dressel[2], and C. A. Kuntscher[1] — [1]Experimentalphysik II, Universität Augsburg, 86159 Augsburg, Germany — [2]1. Physikalisches Institut, Universität Stuttgart, 70550 Stuttgart, Germany

We have performed pressure-dependent x-ray diffraction and infrared spectroscopic studies of the organic low-dimensional conductors $(TMTTF)_2PF_6$ and $(TMTSF)_2PF_6$, which belong to the family of the Bechgaard-Fabre salts. The $(TMTTF)_2PF_6$ salt consists of basically uncoupled molecular stacks (half-filled) and is a prime example of a one-dimensional Mott-Hubbard insulator. On the other hand, the coupling between the stacks in the $(TMTSF)_2PF_6$ salt is high enough to induce metallic conductivity, which is particularly pronounced along the stacking direction. The application of external pressure increases the interstack hopping in the Bechgaard-Fabre salts and allows for a continuous tuning of their electronic properties.

Our pressure-dependent x-ray diffraction data evidence a structural phase transition in $(TMTTF)_2PF_6$ and $(TMTSF)_2PF_6$ salts at about 5 and 8 GPa, respectively. Furthermore, we found a pressure-induced deconfinement transition from a one-dimensional Mott-Hubbard insulating state to a higher dimensional metallic state in $(TMTTF)_2PF_6$ at about 2 GPa. The possible influence of the pressure-induced structural phase transition on the electronic properties is also discussed.

Supported by the DFG, Emmy Noether-program. Provision of beamtime at the ANKA Angströmquelle Karlsruhe is acknowledged.

TT 26.4 Thu 14:45 H19

Valence, spin and orbital states of the quasi-one-dimensional Ca_3CoRhO_6: band structure calculations and x-ray absorption spectroscopy study — •Hua Wu, Zhiwei Hu, Tobias Burnus, Daniel Khomskii, and Liu Hao Tjeng — II. Physikalisches Institut, Universität zu Köln, Zülpicher Straße 77, 50937 Köln

Quasi-one-dimensional cobaltate $Ca_3Co_2O_6$ [1,2] and its isostructural Ca_3CoRhO_6 have drawn attention recently due to the peculiar crystal structure and the fascinating magnetic properties. The valence (and orbital) state issue and the origin of the intra-chain Ising ferromagnetism remain unresolved for Ca_3CoRhO_6. Taking the insulating state of this material as a key finding, we applied the density-functional theory plus Hubbard U (DFT+U) method to study its electronic structure. We find that Ca_3CoRhO_6 has the high-spin Co^{2+} and low-spin Rh^{4+}, and that it is the spin-orbit coupling which lifts the Co^{2+} orbital degeneracy, thereby enabling the DFT+U to generate the band gap. We predict that the Co^{2+} ion has a huge orbital magnetic moment of $1.7\mu_B$, which accounts for the Ising magnetism. We also propose a model to explain the intra-chain ferromagnetism. Those results are confirmed by our x-ray absorption spectroscopy and x-ray magnetic circular dichroism study.

[1] Hua Wu, M. W. Haverkort, Z. Hu, D. I. Khomskii, and L. H. Tjeng, Phys. Rev. Lett. **95**, 186401 (2005).

[2] T. Burnus, Z. Hu, M. W. Haverkort, J. C. Cezar, D. Flahaut, V. Hardy, A. Maignan, N. B. Brookes, A. Tanaka, H. H. Hsieh, H.-J. Lin, C. T. Chen, and L. H. Tjeng, Phys. Rev. B **74**, 245111 (2006).

TT 26.5 Thu 15:00 H19

Lattice response at the Mott Transition in a Quasi-2D Organic Conductor — •Mariano de Souza[1], Andreas Brühl[1], Christian Strack[1], Bernd Wolf[1], Dieter Schweitzer[2], and Michael Lang[1] — [1]Physikalisches Institut, J. W. Goethe-Universität, Frankfurt am Main — [2]3. Physikalisches Institut, Universität Stuttgart, Stuttgart

The Mott transition, which is the metal-insulator (MI) transition driven by electron-electron interactions, is one of the key topics of research in the field of strongly correlated electron systems. Deuterated salts of the organic κ-$(BEDT\text{-}TTF)_2Cu[N(CN)_2]Br$ charge-transfer salts, here BEDT-TTF (or simply ET) denotes the donor molecule bis(ethylenedithio)tetrathiafulvalene and X a monovalent anion, have been recently discussed in this context. In this contribution we report on the direct observation of the lattice response through the Mott transition in the above-mentioned compound. Discontinuous changes of the lattice parameters at the Mott transition are detected by high-resolution dilatometry experiments. The uniaxial expansivities uncover a striking and unexpected anisotropy. A second-order phase transition is observed near the end-point of the first-order transition line T_{MI}. The extraordinarily large lattice response there provides a sensitive thermodynamic probe to explore the critical behavior. The analysis yields a singular contribution with a critical exponent $\tilde{\alpha} = 0.6 \sim 0.9$ and indicates the particular role of inhomogeneities giving rise to a broadening of the transition.

TT 26.6 Thu 15:15 H19

Electron-Phonon Interaction and Antiferromagnetic Correlations — •Giorgio Sangiovanni[1], Olle Gunnarsson[1], Erik Koch[2], Claudio Castellani[3], and Massimo Capone[3,4] — [1]Max-Planck Institut für Festkörperforschung, Stuttgart — [2]Institut für Festkörperforschung, Jülich — [3]University of Rome "La Sapienza", Rome, Italy — [4]INFM-SMC and Istituto dei Sistemi Complessi, Consiglio

Nazionale delle Ricerche, Rome, Italy

Recent experiments suggesting sizeable lattice effects in the cuprates raise the issue of the the role of electron-phonon (e-ph) interaction in strongly correlated systems.

By means of Dynamical Mean-Field Theory, we show that, in the Hubbard-Holstein model, antiferromagnetic (AF) correlations strongly enhance the effects of the e-ph coupling with respect to the paramagnetic phase, even though the net effect of the Coulomb interaction is a moderate suppression of the e-ph interaction.

Doping weakens the AF correlations and reduces the effects of the e-ph, leading to a scenario in which the tendency to polaron formation is weakened by doping, in agreement with the experimental results.

TT 26.7 Thu 15:30 H19

Spin wave dispersion in the helical spin ordered system $SrFeO_3$ and $CaFeO_3$ — •C. Ulrich[1], M. Reehuis[1,2], G. Khaliullin[1], V. Damljanovic[1], A. Maljuk[1,2], A. Ivanov[3], K. Schmalzl[3], Ch. Niedermayer[4], K. Hradil[5], A. Schneidewind[5], and B. Keimer[1] — [1]Max-Planck-Institut FKF, Stuttgart, Germany — [2]Hahn-Meitner-Institut, Berlin, Germany — [3]Institut Laue-Langevin, Grenoble, France — [4]Paul-Scherrer-Institut, Villigen, Switzerland — [5]FRM II, München, Germany

One of the most interesting problems in condensed matter physics is the metal-insulator (MI) transition driven by strong electron correlations. The cubic perovskites $SrFeO_3$ and $CaFeO_3$ are isoelectronic to the manganite system and exhibit also colossal magneto resistance effects. But in contrast, the ferrates show a helical instead of a collinear spin structure. Furthermore, perfectly cubic $SrFeO_3$ shows no charge order and is metallic whereas pseudocubic $CaFeO_3$ shows a MI-transition at the charge ordering transition of 290 K. Therefore, both compounds are right at the borderline between itinerant and strongly correlated electron systems. We have determined the static and dynamic spin properties by neutron scattering. The extracted parameters in the spin Hamiltonian are a big step towards the understanding of the mechanisms behind the helical spin order and the charge order in the ferrates.

15 min. break

TT 26.8 Thu 16:00 H19

Orbitally selective Mott transition in the two-band Hubbard model — •Theodoulos Costi and Ansgar Liebsch — Institut für Festkörperforschung, Forschungszentrum Jülich, 52425 Jülich

The two-band Hubbard model with inequivalent bands exhibits as a function of increasing local Coulomb repulsion two, in general quite different, "Mott" transitions at Coulomb interactions U_{c1} and U_{c2} respectively. We use the numerical renormalization group and exact diagonalization methods to investigate the nature of the second "Mott" transition in detail, for isotropic and anisotropic Hund's exchange [1]. The numerical renormalization group approach uses an effective low energy model which is valid for Coulomb interactions $U > U_{c1}$. We show that this model exhibits non-Fermi liquid and bad metallic behavior in the orbitally selective Mott phases for isotropic and anisotropic Hund's exchange coupling, respectively.

[1] A. Liebsch and T. A. Costi, Eur. Phys. J. B**51**, 523 (2006)

TT 26.9 Thu 16:15 H19

Orbital-ordering and phase transitions in the Mott insulators $LaVO_3$ and YVO_3 — •Eva Pavarini[1], Molly Raychaudhury[2], and Ole Andersen[3] — [1]Institut fuer Festkoerperforschung, Forschungzentrum Juelich, D-52425 Juelich, Germany — [2]S.N. Bose National Centre for Basic Sciences, Kolkata, India — [3]Max-Planck-Institut fuer Festkoerperforschung, Stuttgart, Germany

We calculate the electronic structure of the Mott insulating $3d^2$ perovskites $LaVO_3$ and YVO_3. Using the first-principles NMTO downfolding method we construct a low energy Hubbard Hamiltonian for the 3d t_{2g} bands; we solve this model by using dynamical mean-field theory. The calculated Hubbard bands and Mott gaps are in very good agreement with experimental spectroscopy data. We show that, while in YVO_3 orbital fluctuations are already suppressed at room temperature, in $LaVO_3$ this happens only in the low temperature monoclinic phase. In the low-temperature orbitally-ordered phases both the Jahn-Teller deformations of the VO_6 and the covalent interaction between the empty La (Y) d orbitals and the occupied V t_{2g} orbital concur to determine the type of orbital-ordering.

TT 26.10 Thu 16:30 H19

Spin Peierls Instability, Bond Formation and Orbital Ordering in $MgTi_2O_4$ — •Stefano Leoni, Luis Craco, Miriam Schmitt, and Helge Rosner — MPI CPfS, Dresden, Germany

The spinel titanate $MgTi_2O_4$ undergoes a metal-insulator transition on cooling below T_c= 270 K, with a symmetry lowering from cubic to tetragonal and a collective mutual rotation of the TiO_6 octahedra. This is accompanied by a reorganization of the bonding pattern, which results in bond formation and bond elongation in distinct directions. Also in this titanate, electronic correlation effects, structural distortions and bond breaking pattern are intertwinned and concur to determine the physics of the system. Here we present an electronic structure study of the metal-insulator transition, showing that the latter can be nicely captured by an LDA+U approach. Furthermore, we demonstrate the first order character of the transition, that reflects a complex pattern of bond formation and bond breaking, which modifies the Ti-Ti $d-d$ hopping contributions. In our calculations the onsite-potential U works as a source of local asymmetry at the titanium sites. Along this line, structural distortions and electronic correlation effects can be decoupled, allowing for a closer elucidation of the symmetry lifting across the transition. This in turn allows to follow the onset of orbital ordering from a situation of full degeneracy to a reorganized structures, with changed bond formation.

The Emmy-Noether program is acknowledged for financial support. SL acknowledges the Swiss National Science Foundation for funding.

TT 26.11 Thu 16:45 H19

t_{2g} orbital order in magnetite — •C. F. Chang[1], C. Schüssler-Langeheine[1], J. Schlappa[1], H. Ott[1], M. W. Haverkort[1], M. Buchholz[1], Z. Hu[1], A. Tanaka[2], D. Schmitz[3], E. Schierle[4], E. Weschke[4], G. Kaindl[4], and L. H. Tjeng[1] — [1]II. Physikalisches Institut, Universität zu Köln — [2]ADSM, Hiroshima University — [3]HMI c/o BESSY — [4]Institut fur Experimentalphysik,Freie Universität Berlin

The electronic structure of the low-temperature phase of magnetite (Fe_3O_4) has been a puzzle for many decades. Recent resonant soft diffraction experiments provided first direct evidence for charge order in this system. Using resonant soft x-ray diffraction at the Fe $L_{2,3}$ resonance we found further evidence for orbital order in this system, which can be recognized from a pronounced polarization dependence of the scattered signal. Due to the cubic-to-monoclinic phase transition in magnetite, the low temperature phase usually consists of multiple twins with different crystalline orientations, which leads to ambiguities in the quantitative analysis of the polarization dependence. By applying epitaxial strain and weak magnetic fields to a thin film of magnetite we are able to reduce the number of crystalline twins in the low temperature phase. With the set of spectra taken from this partially un-twinned sample, a quantitative analysis of the character of orbital-order in magnetite becomes feasible. Supported by the DFG through SFB 608.

TT 26.12 Thu 17:00 H19

X-ray magnetic circular dicroism study of $LaMn_{0.5}Co_{0.5}O_3$ — •T. Burnus[1], Z. Hu[1], H. H. Hsieh[2], H.-J. Lin[3], C.-T. Chen[3], P. A. Joy[4], and L. H. Tjeng[1] — [1]II. Physikalisches Institut, Universität zu Köln, Zülpicher Straße 77, 50937 Köln — [2]Chung Cheng Institute of Technology, National Defense University, Taoyuan 335, Taiwan — [3]National Synchrotron Radiation Research Center, 101 Hsin-Ann Road, Hsinchu 30076, Taiwan — [4]Physical and Material Chemistry Division, National Chemical Laboratory, Pune 411008, India

The perovskite $LaMn_{1-x}Co_xO_3$ system shows a multitude of magnetic properties, ranging from the diamagnetic $LaCoO_3$ via ferromagnetism in the mixed region to the antiferromagnetic $LaMnO_3$. For $x = 0.5$ soft-X-ray absorption spectroscopy at the Co-$L_{3,2}$ and Mn-$L_{3,2}$ edge reveals the divalent state for cobalt ions and the tetravalent for manganese ions. X-ray magnetic circular dichroic (XMCD) spectra indicate ferromagnetic coupling between Co^{2+} ions and Mn^{4+} ions. We found from the analysis of the XMCD spectra using configuration-interaction cluster calculations that the orbital moment $\langle L_z \rangle$ of Co^{2+} is very sensitive to tetrahedral distortions of the CoO_6 octahedron. $\langle L_z \rangle$ is close to 1 for the undistorted CoO_6 octahedron and becomes smaller or larger than 1 for elongated or compressed octrahedra, respectively.

TT 26.13 Thu 17:15 H19

Unexpected line shapes and Cross Section Effects in Hard X-ray Photoelectron Spectroscopy of transition metal oxides — •T.C. Koethe[1], Z. Hu[1], C. Schüssler-Langeheine[1], J. Gegner[1],

C.F. Chang[1], G. Panaccione[2], F. Offi[3], and L.H. Tjeng[1] — [1]II. Physikalisches Institut, Universität zu Köln — [2]TASC, Trieste, Italy — [3]Dept. Physics, University Rome III, Italy

The recent progress in Hard X-ray Photoelectron Spectroscopy (HXPES) has facilitated access to bulk sensitive spectroscopic information that was previously unavailable. The large kinetic energies of photoelectrons in HXPES yield inelastic mean free paths of the order of 100 Å, thus providing essentially bulk sensitive results. In this respect, HXPES is an important improvement over standard photoemission in the soft x-ray or UV range having considerable surface contribution to the spectra. For correlated systems, this surface sensitivity is particularly problematic due to the possibly strong modifications of the electronic structure at the surface of these systems. We have investigated a number of simple transition metal (TM) oxides in order to study the effects of variations in the photoionization cross sections for high photon energy spectra. We find that the line shapes of the valence band spectra are strongly modified as compared to lower photon energy results. In particular, we observe strongly enhanced contributions of the TM 4*s* which are two orders of magnitude more intense than in the soft x-ray regime. These results are of importance for the conception and interpretation of HXPES in correlated systems.

TT 27: Symposium "Graphene"

Time: Thursday 14:00–16:40 Location: H20

Invited Talk TT 27.1 Thu 14:00 H20

Graphene: New bridge between condensed matter physics and QED — •Mikhail Katsnelson — Radboud Universiteit Nijmegen, Toernooiveld 1, Nijmegen, 6525 ED, THe Netherlands

Graphene, which is the first example of truly two-dimensional crystals (it's just one layer of carbon atoms) turns out to be gapless semiconductor with unique electronic properties resulting from the fact that charge carriers in graphene demonstrate charge-conjugation symmetry between electrons and holes and possess an internal degree of freedom similar to chirality of ultrarelativistic elementary particles. It provides unexpected bridge between condensed matter physics and quantum electrodynamics. In particular, the Klein paradox of relativistic quantum mechanics is of crucial importance for design of carbon-based transistors; vacuum polarization around charge impurities is essential to understand electron mobility; *index theorem* explains anomalous quantum Hall effect in graphene.

TT 27.2 Thu 14:30 H20

Magnetic confinement of massless Dirac fermions in graphene — A. De Martino, L. Dell Anna, •W. Häusler, and R. Egger — Heinrich-Heine-Universität Düsseldorf,*Institut für Theoretische Physik IV, Universitätsstraße*1, Gebäude 25.32, D-40225 Düsseldorf

Due to Klein tunneling, electrostatic potentials are unable to confine Dirac electrons. We discuss how to solve the corresponding Dirac equation for massless fermions, describing electrons in a monolayer of graphene, in the presence of various profiles of *inhomogeneous* magnetic fields. As a result, discrete electronic levels are obtained, similar as for the familiar electrostatic Schrödinger quantum dot.

TT 27.3 Thu 14:55 H20

Designing pencil traces for spintronics (SWITCHED WITH HL 49.1) — •Inanc Adagideli, Michael Wimmer, Savas Berber, Klaus Richter, and David Tomanek — Universität Regensburg, 93040 Regensburg, Germany

Monolayers of graphite have attracted much theoretical and experimental attention recently, owing to their nearly massless charge carriers and the internal spin-like degrees of freedom. We explore the use of conventional spin and spin-like degrees of freedom for spintronics in undoped and doped systems related to graphene. To this end we consider mono- and bi-layer strips consisting of sp^2 bonded carbon or BN and identify their electronic and spin-like degrees of freedom, corresponding to sublattice and valley degeneracy structure, using ab initio calculations. Based on quantum transport calculations, we determine how spin polarized currents could be generated, manipulated, and detected.

D.T. acknowledges financial support by NSF NIRT grant ECS-0506309, the NSF NSEC grant EEC-425826, and the Humboldt Foundation. I.A., M.W., S.B. and K.R. acknowledge financial support by DFG (SFB 689 and GRK 638)

Invited Talk TT 27.4 Thu 15:20 H20

Transport properties of mesoscopic graphene — •Björn Trauzettel — Department of Physics and Astronomy, University of Basel, CH-4056 Basel, Switzerland

Two recent experiments have discovered that the conductivity of graphene (a single atomic layer of carbon) tends to a minimum value of the order of the quantum unit e^2/h when the concentration of charge carriers tends to zero. This quantum-limited conductivity is an intrinsic property of two-dimensional Dirac fermions (massless excitations governed by a relativistic wave equation), which persists in an ideal crystal without any impurities. In the absence of impurity scattering, and at zero temperature, one might expect the electrical current to be noiseless. In contrast, we show that the minimum in the conductivity is associated with a maximum in the Fano factor (the ratio of noise power and mean current). The Fano factor at zero carrier concentration takes on the universal value 1/3 for a wide and short graphene strip. This is three times smaller than the Poissonian noise in a tunnel junction and identical to the value in a disordered metal. We discuss the relation of this result to the phenomenon of zitterbewegung which is present for free Dirac fermions but absent for free Schrödinger fermions.

Work done in collaboration with C.W.J. Beenakker, Ya.M. Blanter, A.F. Morpurgo, A. Rycerz, M. Titov, and J. Tworzydlo.

TT 27.5 Thu 15:50 H20

Scattering approach to disordered graphene — •Mikhail Titov — University of Konstanz, Theoretical Solid State Physics, Department of Physics, M703, D-78457 Konstanz, Germany

Low-energy charge excitations in graphene are described by the "relativistic"massless Dirac equation, which is behind many exotic transport phenomena observed in this material. The quasiparticle density of states in graphene vanishes at zero doping when the chemical potential coincides with the Dirac electron-hole degeneracy point. Nevertheless the experiments demonstrate that the conductivity at this point reaches a finite minimal value of the order of $4e^2/h$. Based on the scattering approach to the charge transport we provide a comprehensive description of the observed behaviour, which relies on the universal quasiparticle tunneling. We investigate the role of different types of disorder and conclude from comparison with experimental data that existing graphene samples possess a strong potential disorder, which is smooth on atomic scales.

TT 27.6 Thu 16:15 H20

Hofstadter butterflies of carbon nanotubes and graphitic structures (SWITCHED WITH HL 49.3) — •Norbert Nemec and Gianaurelio Cuniberti — Institut für Theoretische Physik, Universität Regensburg, 93040 Regensburg

The electronic spectrum of a two-dimensional square lattice in a perpendicular magnetic field has become known as the Hofstadter butterfly [Hofstadter, Phys. Rev. B 14, 2239 (1976)]. We have calculated quasi-one-dimensional analogs of the Hofstadter butterfly for carbon nanotubes (CNTs) and graphene. Single-wall CNTs and graphene nanoribbons in perpendicular magnetic fields show a rich, pseudofractal spectrum, that can be related to the butterfly of planar graphene. In double-wall CNTs, the interlayer interaction adds modulations in the spectrum that can be understood by studying the effects of intense magnetic fields onto bilayer graphene which is per se an interesting material due to its anomalous quantum Hall effect that could recently be measured in experiment.

TT 28: Transport - Poster Session

Time: Thursday 14:00–17:45 Location: Poster A

TT 28.1 Thu 14:00 Poster A

Conductance Measurements on Bismuth Nanobridges — •Hans-Fridtjof Pernau, Christian Schirm, and Elke Scheer — University of Konstanz, Department of Physics, 78457 Konstanz, Germany

By electron beam lithography and reactive ion etching we fabricate freestanding metallic bismuth nano-bridges which serve as starting point for arranging atomic-size and tunnel contacts with the help of the mechanically controlled breakjunction technique. Since the bridges are broken in cryogenic vacuum, the contacts are free of oxygen or other contamination. The transport measurements are performed in a ^{3}He cryostat in the temperature range from 0.25 K up to 2 K and in transverse magnetic fields up to 8 T. After determining the preferred conductance values by recording conductance histograms, we study the conductance as a function of temperature, bias voltage and magnetic field at various contact values corresponding to those preferred conductance values. We observe reproducible conductance fluctuations as a function of both bias voltage and magnetic field and a well pronounced zero-bias anomaly which is modulated periodically with the magnetic field. We interprete our data in terms of phase coherent transport and onsetting superconductivity due to the granular structure of the film.

TT 28.2 Thu 14:00 Poster A

Few-atom contacts: behavior at high electric currents — •Christian Schirm, Jochen Grebing, and Elke Scheer — Fachbereich Physik, Universität Konstanz, D-78457 Konstanz

We investigated metallic point contacts arranged with the mechanical controllable break junctions (MCB) technique of gold and aluminum at high voltages up to 1 Volt. Two mechanisms that influence the electrical resistance can be observed and studied in this regime: conductance fluctuations as function of the voltage, but also atomic rearrangements that change the conductance abruptly.

Measurements with lithographically fabricated MCB were performed in vacuum at 1.5K. Statistically atomic-size contacts adopt preferred conductance values [1]. A conductance close to these values is assumed to indicate a more stable atomic confirmation of the contact. Unexpectedly we find that when increasing the current, the conductance has the tendency to increase stepwise and eventually jump to zero. A statistical analysis of 500 such cycles will be presented. As a result the preferred conductance values just before break correspond to those found in histograms recorded for small currents [1].

Also the influence of the bias voltage on the transport properties of gold MCB has been studied at ambient conditions. First histograms taken for bias values up to 400mV seem to show a decrease in the height of the first two conductance peaks while their position stays the same. This is in accordance with work using different techniques [2].

[1] B. Ludoph, J.M. van Ruitenbeek, Phys. Rev. B 61, 2273 (2000)
[2] A. Sakai et al., Phys. Rev. B 72, 045407 (2005)

TT 28.3 Thu 14:00 Poster A

Transport measurements on nanostructured point contacts of quench-condensed Ag — •Torben Peichl, Marcel Spurny, Michael Burst, and Georg Weiss — Physikalisches Institut, Universität Karlsruhe, 76128 Karlsruhe, Germany

We report on the successful fabrication of nanostructured point contacts of disordered Ag. In the first preparation step we used electron beam lithography and SF_6 plasma etching to obtain nano-sized holes in an insulating silicon nitride membrane. Subsequent evaporation of Au onto one and Ag onto the other side of the membrane resulted in metallic point contacts. Highly disordered Ag point contacts were achieved by quench-condensing Ag films at low temperatures <10K.

Electronic transport properties of these point contacts were studied by measuring the differential resistance using lock-in methods. Our results showed distinct non-linear behavior in the region around ±1mV so-called zero bias anomalies, which are usually attributed to two-level tunneling. We also noticed spikes at higher voltages which may be related to reversible conductance transitions.

In principle, we could obtain very reproducible conductance behavior of certain sample series. However, with almost equal preparation conditions we sometimes observed huge differences between our samples. We therefore studied in more detail the geometries of our point contacts by employing focused ion beam cutting and SEM imaging.

TT 28.4 Thu 14:00 Poster A

Low Temperature Magnetoresistance Measurements on Bismuth Nanowire Arrays — •Christoph Kaiser[1,2], Georg Weiss[1], Thomas Cornelius[3], Maria Eugenia Toimil-Molares[3], and Reinhard Neumann[3] — [1]Physikalisches Institut, Universität Karlsruhe, D-76128 Karlsruhe — [2]New address: Institut für Mikro- und Nanoelektronische Systeme, Universität Karlsruhe, D-76187 Karlsruhe — [3]Gesellschaft für Schwerionenforschung, D-64291 Darmstadt

We created nanoporous templates by exposing polymeric foils to heavy ion radiation. In these templates, single-crystalline bismuth nanowires were fabricated by electrochemical deposition. The resistance and magnetoresistance of these nanowires were studied at low temperatures. We present our results and compare them with the common theories and results of other groups, respectively.

We obeserved an unexpected effect in the low temperature resistance of our nanowires when a magnetic field was present. This novel effect could be related to the temperature dependence of the magnetoresistance. Furthermore, a clear $B^{1.5}$ dependence of the transverse magnetoresistance was found. The expected T^2 dependence of the resistance at low temperatures is confirmed in the temperature range $1.5\ K < T < 10\ K$. Finally, a steplike increase in the magnetoresistance of our sample with a wire diameter of 100 nm was found, extending the results of Heremans et al. to larger diameters. This effect is attributed to a transition from one- to three-dimensional localization.

TT 28.5 Thu 14:00 Poster A

Elektrische Messungen an Kohlenstoff-Nanoröhren — •René Geithner, Holger Mühlig, Matthias Büenfeld, Matthias Grube, Frank Schmidl, Bernd Schröter, Wolfgang Richter und Paul Seidel — FSU Jena; Institut für Festkörperphysik, Helmholtzweg 5, 07743 Jena

Kohlenstoff-Nanoröhren sind nanoskopische, eindimensionale Leiter, die durch ihre Geometrie interessante elektrische Eigenschaften besitzen [1].

Bei den gezeigten Proben handelt es sich um einwandige Kohlenstoff-Nanoröhren [Single-Walled Carbon Nanotubes - SWNTs], die mit Gold elektrisch ankontaktiert sind. Mit einem Back-Gate wird so ein Feld-Effekt-Transistor realisiert.

Die Messungen zeigen, dass bei Raumtemperatur eine sowohl von der Gatespannung abhängige als auch unabhängige Leitfähigkeit der SWNTs nachgewiesen werden konnte. Diese Ergebnisse passen in das Bild der metallischen bzw. halbleitenden Nanoröhren. Bei den halbleitenden Nanoröhren können durch das Gate Leitfähigkeitsänderungen um mehrere Größenordnungen erreicht werden.

Weiterhin konnten bei tiefen Temperaturen Quanteneffekte an Nanoröhren nachgewiesen werden. Diese Effekte wurden aurf ihre Temperaturabhängigkeit untersucht.

Die dsikutierten Messungen wurden in einem Temperaturbereich von 10mK bis 300K aufgenommen.

TT 28.6 Thu 14:00 Poster A

Coherent laser control of the current through molecular junctions — Guangqi Li[1], Michael Schreiber[2], and •Ulrich Kleinekathöfer[1] — [1]International University Bremen (Jacobs University Bremen as of spring 2007), Campus Ring 1, 28759 Bremen — [2]Institut für Physik, Technische Universität Chemnitz, 09107 Chemnitz

The tunneling current through a single site molecular junction coupled to two leads is studied under the effect of an external field using a master equation approach [1]. In the case of a small bias and a high carrier frequency of the external field, the current through the molecular junction vanishes completely for certain parameters of the external field. This phenomenon is known as coherent destruction of tunneling [2]. For larger bias voltages, further tunneling channels participate in the electron conduction and therefore the current does not vanish anymore. This is known as photon-assisted tunneling and leads to steps in the current-voltage characteristics. The described phenomenon could be used for ultrafast optical switching of the current through molecular junctions.

[1] S. Welack, M. Schreiber, and U. Kleinekathöfer, J. Chem. Phys. 124, 044712 (2006).

[2] U. Kleinekathöfer, G.-Q. Li, S. Welack, and M. Schreiber, Europhys. Lett. 75, 139 (2006).

TT 28.7 Thu 14:00 Poster A

Structural Characterisation and Spin-Dependent Transport of Single Wall Carbon Nanotubes — •Dominik Preusche Preusche[1], Silvia Schmiedmaier[1], Emiliano Pallecchi[1], SungHo Jhang[1], Benoit Witkamp[2], Herre van der Zant[2], and Christoph Strunk[1] — [1]Institut für Angewandte und Experimentelle Physik, Universität Regensburg — [2]TU Delft

We investigate spin-dependent transport in and characterise the structure of individual carbon nanotubes. Low temperature magnetoconductance was found to be also gate-dependent and showed spin-valve effect, Coulomb blockade and spin-1/2 Kondo effect. Furthermore, suspended nanotubes have been investigated with a TEM. In particular, their chiral indices can be identified by means of selected area electron diffraction. The micromagnetic properties of the ferromagnetic PdFe contacts as well as their hysteretic magnetic switching have been studied by means of Lorentz microscopy and SQUID measurements. When performed on the same nanotube, structural characterisation will facilitate the interpretation of the magnetoconductance measurements and allow more direct comparison with theoretical simulations.

TT 28.8 Thu 14:00 Poster A

Hall effect and magnetoresistance of single-walled carbon nanotubes — •sung-ho jhang[1,3], seung-hyun lee[1], ursula dettlaff[2], dongsu lee[1], siegmar roth[2], and yung-woo park[1] — [1]School of Physics, Seoul National University, Seoul, Korea — [2]Max-Planck-Institute for solid state research, Stuttgart, Germany — [3]Institute of Experimental and Applied Physics, University of Regensburg, Regensburg, Germany

We report Hall coefficient and magnetoresistance measurements on films and networks of single-walled carbon nanotubes(SWNTs). Four different types of SWNTs are prepared as films; Purified SWNTs synthesized either by HiPCO (High-Pressure CO Conversion) process or by laser ablation method (laser SWNTs), plus those SWNTs chemically treated by $SOCl_2$. $SOCl_2$-modified SWNTs show higher conductivity due to doping effect. The carrier density is determined to be $\sim 10^{22}cm^{-3}$ for HiPCO or $SOCl_2$-modified SWNTs, and $\sim 10^{21}cm^{-3}$ for laser SWNTs. Considering that theoretically predicted carrier density of metallic SWNT is $\sim 10^{22}cm^{-3}$ and that of semiconducting SWNT is $\sim 10^{20}cm^{-3}$, the difference in carrier density between HiPCO and laser SWNTs can be originated from the difference in the ratio of metallic and semiconducting SWNTs in both films. While Hall coefficient is positive in the whole temperature range of 1.4-300K for HiPCO and $SOCl_2$-modified SWNTs, Hall coefficient of laser SWNTs shows a sign change around T = 15K. The magnetoresistance of SWNTs studied in high magnetic fields up to 33T, and in a temperature range of 0.4-300K will be also presented.

TT 28.9 Thu 14:00 Poster A

Electronic Transport through C_{60} — Tobias Böhler, •Achim Edtbauer, and Elke Scheer — FB Physik - Universität Konstanz

The electronic transport through a single or a few C_{60} molecules is studied experimentally with the help of the mechanically controllable break-junction (MCB) technique [1]. The tip electrodes of the MCB are fabricated of aluminum or gold. The molecule is evaporated onto an opened break-junction under UHV conditions and at low temperatures. At room and low temperature the experiment shows evidence that the conductance of a single C_{60} molecule between gold contacts is in the order of 0,1 G_0. This can be seen in opening and closing curves, by statistical analysis (conductance histograms) and by the presence of time-dependent fluctuations of the conductance. The differential conductance of individual contacts measured - for those values of conductance which in the statistical measurements have shown to be the preferred ones - reveal fluctuations on the voltage scale of several mV. We discuss the typical behavior of the different conductance regimes. Only for very few contacts the differential conductance indicates the excitation of vibrational modes. [1] T. Böhler et al. Nanotechnology 15 (2004) 465

TT 28.10 Thu 14:00 Poster A

Conductivity through single Ferrocenedithiol molecules — •Jedrzej Schmeidel[1], Gernot Gardinowski[1], Herbert Pfnür[1], Christoph Tegenkamp[1], Volodymyr Maslyuk[2], Ingrid Mertig[2], and Mads Brandbyge[3] — [1]Institut für Festkörperphysik, Leibniz-Universität Hannover, 30167 Hannover, Germany — [2]Theoretische Physik, Martin-Luther-Universität Halle-Wittenberg , 06099 Halle, Germany — [3]Mikroelektronik Centret, Technical University of Denmark, Kongens Lyngby, Denmark

We have investigated systematically the fabrication and characterization of metallic nanometer–sized(nm) gaps suitable for conductivity measurements of single molecules. Epitaxially grown Ag nanostructures with a thickness down to 10 monolayers on Si(100) were used for a controlled gap formation by electromigration (EM). The gaps obtained range from several nm down to sub–nm, as revealed by lateral conductivity measurements and by scanning tunneling microscopy done under ultra high vacuum conditions. After adsorption of a single ferrocenedithiol (FDT) molecule in between the gap by self-assembly the zero bias resistance is around 40kOhm. In addition, the dI/dV curve shows molecular contributions which can be attributed to ferrocene induced states near the Fermi edge. In particular, the zero bias resistance is calculated correctly using the TRANSIESTA code. As pre-optimized structures for transport calcuations, the adsorption parameters obtained from VASP are used, assuming a thiolate bound configuration of one molecule in between defect-free Ag contacts.

TT 28.11 Thu 14:00 Poster A

Contacting organic molecules using micro transfer printing — •Stefan Baechle, Artur Erbe, and Elke Scheer — Universität Konstanz, FB Physik, Germany

The formation of metal molecule contacts is one of the main challenges in the fabrication of electronic devices based on the functionality of single molecules. A variety of techniques has already been demonstrated. Most of these processes rely on evaporation of metals or self-organisation of molecules on metals. It has proven to be difficult to separate artifacts from the contacting technique from molecular properties. Therefore contacting techniques, which rely on completely different mechanisms for the formation of the metal molecule contact, are of great importance. Here we demonstrate the fabrication of micron sized contacts using micro transfer printing. The dependence of the conductivity on the area of the contact is studied in order to understand the quality of the contact to individual molecules.

TT 28.12 Thu 14:00 Poster A

Mechanically variable contacts to alkane molecules — •Simon Verleger, Artur Erbe, and Elke Scheer — Universität Konstanz, FB Physik, Germany

Metal-molecule contacts using the mechanically controlled break junction method are demonstrated. The contacted molecules are alkanedithiols. The thiol groups attached to each end ensure chemisorption of the molecules to the gold electrodes. Thus a mechanically stable contact is generated, which can then be tuned by varying the distance between the electrodes. All measurements are performed in a liquid cell containing the molecular solution. We observe clear features in the conductivity as a function of the electrode distance, which can be associated with the exact positioning of the molecules with respect to the electrodes. From this we conclude that we observe transport through a number of molecules. In future experiments this approach will be used to fabricate contacts to single molecules by using molecules with specific chemical properties.

TT 28.13 Thu 14:00 Poster A

Chemical binding of short, thiolated DNA molecules to gold surfaces — •Shou-Peng Liu[1], Benjamin Bornemann[2], Artur Erbe[1], Andreas Marx[2], and Elke Scheer[1] — [1]Universität Konstanz, FB Physik, Germany — [2]Universität Konstanz, FB Chemie

The electrical properties of DNA are currently investigated using various contacting techniques. The ability of the linker group to chemically anchor the DNA molecule on the metal electrodes is of great importance in these experiments. Such a link provides a mechanically and electrically stable connection, which is important for testing the current flowing through the molecules. In this work we present fluorescence microscopy characterization of the immobilization of short DNA molecules on gold. C5-thiol-modified uridine protected with a trimethylsilylethyl-group to prevent the thiol group from oxidation is used. These molecules are found to bind specifically to gold evaporated on a polyimide substrate. Test measurements with unprotected molecules ($C5\text{-}CH_2\text{-}SH$) show no specific binding of the molecules, as well as measurements with molecules without any thiol modification.

TT 28.14 Thu 14:00 Poster A

Peculiarities of non-equilibrium conductance fluctuations —

•Wanyin Cui[1,2], Peter vom Stein[1], Christoph Wallisser[1], and Roland Schäfer[1] — [1]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, Germany — [2]Physikalisches Institut, Universität Karlsruhe, Germany

The quantum mechanical nature of conduction electrons leads to so-called universal conductance fluctuations in mesoscopic wires. We present new experimental results in the non-linear response regime at finite bias voltage. While earlier studies focused on the size of the fluctuation var(G) in the differential conductance, the present work takes a closer look at the critical magnetic field B_c (defined as the half width of the autocorrelation function) as well. A significant decrease of the fluctuation amplitude on a small voltage scale ($V_{\rm dc} \leq 2V_{\rm Th}$, $V_{\rm dc}$ and $V_{\rm Th}$ refer to voltage drop and Thouless energy, respectively) for all investigeted samples is observed. It is accompanied by an increase of B_c for the majority of our samples. Both facts might point to a loss of phase coherence due to self-heating. However, for $V_{\rm dc} > 2V_{\rm Th}$ an overall reduction of B_c is found indicating a further spreadout of the phase coherent region responsible for the fluctuations. The results are discussed with regard to recent theoretical work on non-equilibrium fluctuations.

TT 28.15 Thu 14:00 Poster A

Influence of defects on conductance fluctuations in metallic nanowires — •Michael Wolz, Vojko Kunej, Christian Debuschewitz, and Elke Scheer — Universität Konstanz, Fachbereich Physik, Universitätsstraße 10, D-78457 Konstanz

The goal of the project is to investigate the influence of individual artificial defects on the conductance fluctuations of metallic nanowires. Clear and reproducible conductance fluctuations have been measured.

A STM working in a conventional cryostat at 4 K and in magnetic fields up to 1 T has been developed for creating the defects. In order to position the sample with respect to the STM tip the system is equiped with a x-y-table. On nanostructures which have been fabricated by electron beam lithography and reactive ion etching [1] the succsessful positioning of the stm-tip above the wire is demonstrated. The accessibility of the samples by the STM-tip is realized by shadow evaporation of the metal (Au) onto the substrate.

First low-temperature measurements with additional defects produced with the STM will be presented.

[1] T. Hoss et al., Physica E 14 (2002) 341

TT 28.16 Thu 14:00 Poster A

Super-Poissonian current noise in coupled single-electron transistors — •Björn Kubala[1], Göran Johansson[2], and Jürgen König[1] — [1]TP III, Ruhr-Universität Bochum, Germany — [2]MC2, Chalmers University Göteborg, Sweden

Non-Poissonian noise has been explored theoretically and experimentally in a variety of systems. Here, we investigate zero-frequency noise in networks of coupled single-electron transistors (SETs) within a real-time diagrammatic theory [1]. We calculate noise including all contributions up to second order in the coupling strength, whereby incorporating sequential and standard cotunneling processes, but also renormalization processes and cotunneling involving several transistor islands. For a single SET we reproduce results of orthodox and cotunneling theories and find the familiar suppression of noise in double-barrier systems.

The capacitative coupling of two SETs in parallel, however, permits an investigation of novel correlation effects, e.g., a bunching of electrons also found in semiconductor systems [2]. We identify a number of different mechanisms causing super-Poissonian noise, which could be experimentally investigated in coupled SETs.

[1] B. Kubala, G. Johansson, and J. König, Phys. Rev. B **73**, 165316 (2006).

[2] S. S. Safonov, A. K. Savchenko, D. A. Bagrets, O. N. Jouravlev, Yu. V. Nazarov, E. H. Linfield, and D. A. Ritchie, Phys. Rev. Lett. **91**, 136801 (2003).

TT 28.17 Thu 14:00 Poster A

Conductance fluctuations in inhomogeneous mesoscopic systems — •Alexander Kohler and Wolfgang Belzig — Universität Konstanz, D-78464 Konstanz, Germany

In mesoscopic systems the conductance is influenced by quantum interference effects, such as the weak localization correction and the universal conductance fluctuations. These conductance fluctuations have been observed in magnetic fields and are in some cases independent of sample size and impurity concentration. However, the magnetic field dependence is sensitive to the geometry of the wire and other inhomogeneities. Furthermore it is observed that conductance fluctuations in experiments change only slightly upon rearrangements of the disorder [1].

We investigate systems with a spatially inhomogeneous impurity concentration using standard diagrammatic methods. We find an oscillatory contribution (depending on the layer thickness) to the weak localization correction, reflecting the symmetry of the different diffusion modes in the wire. Complementary to the analysis of [2], we also study the influence of the motion of a single scatterer on the conductance fluctuations of a mesoscopic wire. Such effects can be probed by locally depleting a sample with an AFM.

[1] Elke Scheer, PhD thesis, Universität Karlsruhe, 1995.
[2] Feng, Lee, and Stone, Phys. Rev. Lett. **56**, 1960 (1986).

TT 28.18 Thu 14:00 Poster A

Superconducting microstrip transmission line resonator for flux qubit readout — •Thomas Niemczyk, Susanne Hofmann, Achim Marx, and Rudolf Gross — Walther-Meissner-Institut für Tieftemperaturforschung, Bayerischen Akademie der Wissenschaften, Walther-Meissner Str. 8, 85748 Garching, Deutschland

Coupling superconducting quantum bits to high-quality superconducting resonators opens the fascinating field of cavity quantum electrodynamics (cQED) based on superconducting circuits. Exciting first experiments have recently been performed in Yale [1] with superconducting charge qubits. For cQED experiments using superconducting flux qubits strong coupling between the magnetic field in a suitable resonator and the flux in the qubit is required. We present the design and realization of a high-Q superconducting microstrip resonator for application in c-QED. The resonator is based on the microstrip SQUID amplifier introduced by Mück et al. [2]. We will introduce the fundamental mode of operation of the microstrip resonator and discuss the results of extended simulations of the device parameters and performance. The geometry of the device should allow for a strong qubit-cavity-coupling up to 200 MHz. A first series of superconducting microstrip resonators has been fabricated by Hypres, Inc. We will present the experimental characterization of the S-parameters of various resonators with different resonance frequency and external coupling capacitors.

[1] A. Wallraff *et al.* Nature **431**, 162 (2004).
[2] M. Mück and J. Clarke, J. Appl. Phys. **88**, 6910 (2000)
This work is supported by the DFG via SFB 631.

TT 28.19 Thu 14:00 Poster A

Dynamics of quantum coherence in a spin-1 Heisenberg chain — •Jakob Meineke and Joachim Ankerhold — Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Hermann-Herder-Straße 3, 79104 Freiburg

We study the non-equilibrium dynamics of a one-dimensional spin-1 chain (XXZ Heisenberg model) of finite length. This model can be used to describe many-body-correlations in ultra-cold Rydberg-gases in optical lattices. Our goal is to understand the dynamics of collective modes of the interacting atoms. Of special interest are Förster-like transfer processes, which involve coherent exchange of energy and ultimately lead to an entanglement state of the entire ensemble. We present results obtained by exact diagonalization and by semiclassical methods related to the non-linear sigma-model.

TT 28.20 Thu 14:00 Poster A

Limitation of entanglement due to spatial qubit separation — •Roland Doll, Martijn Wubs, Peter Hänggi, and Sigmund Kohler — Institut für Physik, Universität Augsburg, Universitätsstrasse 1, 86135 Augsburg

We consider spatially separated qubits coupled to a thermal bosonic field which acts as a heat bath and, thus, causes decoherence. By taking the spatial separation of the qubits explicitly into account, the reduced qubit dynamics becomes intrinsically non-Markovian. For pure dephasing we solve the dynamics exactly and explicitly. We first focus on the entanglement of two Bell states which for vanishing separation are known as robust and fragile entangled states. The robustness of two-qubit decoherence-free subspaces depends on temperature, qubit-field coupling strength, and qubit separation. Our exact results are then generalized to an arbitrary number of qubits. We show for weak qubit-bath coupling that a standard Bloch-Redfield approach fails to describe the reduced dynamics even at long times and predicts spurious decoherence-free subspaces. We derive a master equation that does not suffer from such deficiencies. It allows us to directly attribute

the observed non-Markovian features to spatial bath correlations.
[1] R. Doll, M. Wubs, P. Hänggi, and S. Kohler, Europhys. Lett. **76**, 547 (2006).

TT 28.21 Thu 14:00 Poster A

Gauging a quantum heat bath with dissipative Landau-Zener transitions — •Martijn Wubs[1], Keiji Saito[2], Sigmund Kohler[1], Peter Hänggi[1], and Yosuke Kayanuma[3] — [1]Institut für Physik, Universität Augsburg — [2]University of Tokyo, Japan — [3]Osaka Prefecture University, Japan

We calculate the exact Landau-Zener transition probabilities for a qubit with arbitrary linear coupling to a bath at zero temperature [1]. The final quantum state exhibits a peculiar entanglement between the qubit and the bath. In the special case of a diagonal coupling, the bath does not influence the transition probability, whatever the speed of the Landau-Zener sweep. It is proposed to use Landau-Zener transitions to determine both the reorganization energy and the integrated spectral density of the bath. Possible applications include circuit QED and molecular nanomagnets.
[1] M. Wubs *et al.*, Phys. Rev. Lett. **97**, 200404 (2006).

TT 28.22 Thu 14:00 Poster A

Design of a Flux Qubit with a nondestructive Readout System — •Christoph Kaiser, Andreas Graf, and Michael Siegel — Institut für Mikro- und Nanoelektronische Systeme, Universität Karlsruhe, D-76187 Karlsruhe

We are studying flux qubits based on $Nb/Al/Al_2O_3/Nb$ tunnel junctions. The qubit consists of three Josephson tunnel junctions connected in series in a superconducting loop and is read out by an inductively coupled SQUID. In order to obtain a nondestructive readout, the SQUID is part of an LC circuit, whose resonant frequency depends on the inductance of the SQUID and hence on the qubit state [1].

We have carried out numerical simulations in order to obtain values for the minimum energy level splitting Δ and the persistent current I_p. Suitable design parameters were found and the influence of possible parameter deviations due to fabrication tolerances was studied. Furthermore, we investigated methods to reduce the stray inductance of the readout LC circuit and hence increase the readout resolution.
[1] A. Lupasçu et al., Phys. Rev. Lett. 93, 177006 (2004).

TT 28.23 Thu 14:00 Poster A

Superconducting coplanar waveguide resonators for flux qubit readout — •Markus Rösch, Stefan Wünsch, Alexander Stassen, Hansjürgen Wermund, and Michael Siegel — Institut für Mikro- und Nanoelektronische Systeme, Universität Karlsruhe, D-76187 Karlsruhe

The usage of an transmission line resonator offers a method for flux qubit readout. For a required weak electromagnetic coupling there is a need for a high quality factor Q_L of the cavity circuit to detect small deviations in the resonance frequency.

We developed various superconducting niobium coplanar waveguide resonators for a resonance frequency of 3 GHz and a linewidth of 50 μm. Different layouts for the resonator were designed, simulated and measured on a silicon substrate at 4.2 K. We found a very good agreement between simulation and measurement results. The presented results showed a big influence of the substrate properties in respect of Q_L. To analyse the dependence of this value we implemented the resonator structure with the highest Q_L value on a sapphire substrate. In respect of the lower losses in the substrate we obtained an increasing of Q_L. Finally we discuss the results and give an outlook of future activities.

TT 28.24 Thu 14:00 Poster A

Implementation of Two-Cell Flux Qubits — •Alexey Feofanov[1], Benjamin Hinrichs[1], Abdufarrukh Abdumalikov[1,2], and Alexey Ustinov[1] — [1]Physikalisches Institut III, Universität Erlangen-Nürnberg, Erlangen, Germany — [2]Present address: Frontier Research System, RIKEN, Wako, Japan

The standard superconducting flux qubit first implemented at Delft [1] consists of a superconducting loop with three Josephson junctions, one of which is smaller than the other two, nominally identical junctions. This circuit features a double well potential at half frustration. Its limitation is that the barrier height cannot be changed without breaking the potential symmetry. An alternative device proposed by Yukon [2] is a two-cell flux qubit containing four Josephson junctions. The two-cell flux qubit can be made using identical junctions and features a double-well potential with orthogonal controls for the barrier height and the potential symmetry. We have designed and fabricated aluminum-based two-cell qubits with dc-SQUID readout and flux line controls. The useful feature of our latest two-cell qubit design is that it can be operated and read out at zero external magnetic field. Experiments to test these devices are currently on the way.
[1] I. Chiorescu, Y. Nakamura, C.J. Harmans, and J. E. Mooij, Science **299**, 1869 (2003)
[2] S.P. Yukon, Physica C **368**, 320 (2002)

TT 28.25 Thu 14:00 Poster A

Dispersive Readout Scheme for Josephson Phase Qubits — •Tobias Wirth, Jürgen Lisenfeld, Alexander Lukashenko, and Alexey V. Ustinov — Physikalisches Institut III, Universität Erlangen, Germany

Superconducting qubits require appropriate isolation from the bias leads, which can be achieved by the use of superconducting transformers. A superconducting loop with a tunnel junction can be used to prepare a double-well potential, where the discrete quantum levels in one well form the qubit states. State-dependent tunneling to the other well changes the magnetic flux in the qubit loop measured by a dc-SQUID. A standard phase qubit readout by the dc-SQUID requires switching to the non-superconducting state, which generates heat and quasiparticles in the circuitry. This results in long cool-down times after each switching event and thus limits the repetition rate of the experiment. In our ongoing experiments, we replace the standard scheme by a high-frequency readout based on a weakly-dissipative measurement of the dc-SQUID Josephson inductance, which in turn depends on the flux in the dc-SQUID. This is done by detecting a phase change of the probe signal reflected from an LC-tank circuit coupled to the dc-SQUID. The expected benefits include longer coherence times, much faster measurements, and a possibility of applying non-destructive measurement schemes to Josephson phase qubits.

TT 28.26 Thu 14:00 Poster A

On-Chip Detection of Single Microwave Photons in Superconducting Circuit QED — •Ferdinand Helmer[1], Matteo Mariantoni[2], Florian Marquardt[1], and Enrique Solano[1] — [1]Arnold Sommerfeld Center for Theoretical Physics, Department für Physik, Center for NanoScience, Ludwig-Maximilians-Universität München, Germany — [2]Walther Meissner Institut, Bayerische Akademie der Wissenschaften, Garching b. München, Germany

We propose and analyze a scheme for detecting single microwave photons traveling along a superconducting transmission line on a chip. The setup exploits a nonlinear coupling between different modes in a transmission line resonator, brought about by the interaction with a superconducting qubit (as demonstrated in recent experiments). Remarkably, the backaction produced by the measurement device may produce a fundamental limit for the fidelity of photon detection in any such scheme. This is a consequence of the Quantum Zeno effect, and we discuss both analytical estimates and quantum trajectory simulations of the measurement process.

TT 28.27 Thu 14:00 Poster A

Design, fabrication and characterization of microwave resonators for circuit Quantum Electrodynamics — •Susanne Hofmann, Thomas Niemczyk, Mattes Mariantoni, Achim Marx, and Rudolf Gross — Walther-Meissner-Institut für Tieftemperaturforschung, Bayerischen Akademie der Wissenschaften, Walther-Meissner Str. 8, 85748 Garching, Germany

A central issue in quantum information processing is the coupling of quantum bits (qubits) to a suitable readout system. In 2004 Wallraff et al. realized the strong coupling of microwave photons in a coplanar waveguide resonator to a superconducting (sc) charge qubit. To achieve strong coupling between the microwave field and the charge qubit, it is placed at the maximum of the electric field in the resonator. Furthermore, the resonator needs a high quality factor which can be achieved for sc resonators coupled weakly to the environment. With a single photon in the cavity, vacuum rabi splitting in the resonator - qubit system can be observed. We have designed and fabricated sc resonators that are designed for coupling with sc flux qubits. Flux qubits couple to the magnetic field mode of the field in the resonator. The length of the resonators is designed to be half a wavelength in order to achieve maximum coupling in the middle of the resonators. This results in short resonators without the need for a meandering geometry. Various designs with different geometries and coupling to the environment have been fabricated from niobium on silicon and sapphire substrates.

This work is supported by the DFG via SFB 631.

TT 28.28 Thu 14:00 Poster A

Relaxation of Josephson qubits due to bistable fluctuators — •Clemens Müller, Alexander Shnirman, and Gerd Schön — Institut für Theoretische Festkörperphysik, Universität Karlsruhe, 76128 Karlsruhe

Decoherence is a major problem for the use of superconducting Josephson qubits in quantum information processing. Recent measurements of the relaxation time T_1 of Josephson charge qubits reveal strongly non-monotonic behavior as a function of the energy splitting (e.g. [1] [2]), the origin of which is not understood.

As a possible model we study the relaxation time T_1 of a Josephson qubit coupled to an environment of bistable fluctuators. For two cases the behavior is well understood. These are weak coupling to a large number of fluctuators, and strong coupling to a single fluctuator. In our work we examine a Josephson qubit coupled to a finite number of fluctuators. We consider the case that the fluctuators are coherent and the energy splitting of each fluctuator is influenced by all others.

[1] G. Ithier et al., Phys. Rev. B **72**, 134519 (2005)
[2] O. Astafiev et al., Phys. Rev. Lett. **93**, 267007 (2004)

TT 28.29 Thu 14:00 Poster A

Adiabatic pumping through a quantum dot in the proximity of a superconductor — Janine Splettstoesser[1,2], •Michele Governale[2], Jürgen König[2], Fabio Taddei[1], and Rosario Fazio[1,3] — [1]NEST-CNR-INFM & Scuola Normale Superiore, I-56126 Pisa, Italy — [2]Institut für Theoretische Physik III, Ruhr-Universität Bochum, D-44780 Bochum, Germany — [3]International School for Advanced Studies (SISSA), via Beirut 2-4, I-34014 Trieste, Italy

By varying periodically in time some properties of a mesoscopic conductor, a dc current can be produced by a transport mechanism known as pumping. We study adiabatic pumping through a quantum dot tunnel-coupled to one normal and one superconducting lead. We generalize a formula which relates the pumped charge through a quantum dot with Coulomb interaction to the instantaneous local Green's function of the dot[1], to systems containing a superconducting lead. First, we apply this formula to the case of a non-interacting, single-level quantum dot in different temperature regimes and for different parameter choices, and we compare the results with the case of a system comprising only normal leads. Then we study the infinite-U Anderson model with a superconducting lead at zero temperature using the mean-field slave-boson approach, and we discuss the effect of the proximity of the superconductor on the pumped charge.

[1] J. Splettstoesser, M. Governale, J. König, and R. Fazio, Phys. Rev. Lett. **95**, 246803 (2005).

TT 28.30 Thu 14:00 Poster A

Quantum information process with nanometre precession ion implantation — •Inam Mirza — 3. Physikalisches Institut Universität Stuttgart

The spin state of a single nitrogen-vacancy centre in diamond is one of the most attractive candidate for quantum information processing because of its long spin coherence time [1]. Further more coupling (magnetic dipole) between the spins are required for scalable quantum computing (2-qbit operation) [2]. This process requires a high implantation positioning accuracy and nitrogen free clean diamond (<0.1 ppm nitrogen concentration). Here we report recent progress towards single ion implantation within nanometre scale accuracies.

[1] Nature Physics 2: 408-413 (2006).
[2] Science 314 (5797): 281-285 (2006).

TT 28.31 Thu 14:00 Poster A

Theoretical and experimental studies of circuit QED systems — •Matteo Mariantoni, Frank Deppe, and Rudolf Gross — Walther-Meissner-Institute, Garching, Germany

The interaction between superconducting quantum circuits and on-chip resonators has recently become an important research area, referred to as circuit QED. The formalism of circuit QED explains the coupling between a superconducting qubit (charge or flux) and a microwave resonator implemented by means of LC circuits or coplanar wave guide resonators fabricated on a chip. Instead of focusing on the well-known resonant and dispersive regimes, we investigate a deeply dispersive regime, where qubit and resonator are strongly detuned and the transition frequency of the resonator is almost negligible compared to the qubit one. This regime has been exploited experimentally in several different implementations, e.g., the reading-out of a superconducting qubit by means of a low frequency resonator. In this framework, we have developed a simple formalism which encompasses the many explanations given in the literature on the experiments mentioned above. Following these lines, we also introduce the main facts behind our experimental implementation of circuit QED, which will be presented in Part II. This work is supported by the DFG via SFB 631.

TT 28.32 Thu 14:00 Poster A

Measuring the many-body size of a Schrödinger cat state — Florian Marquardt, Benjamin Abel, and •Jan von Delft — Physics Department, Arnold Sommerfeld Center for Theoretical Physics, and Center for NanoScience, Ludwig-Maximilians Universität Munich

We propose a measure for the "many-body size" of a Schrödinger cat state, i.e. a quantum superposition of two many-body states with (supposedly) macroscopically distinct properties, by counting how many single-particle operations are needed to map one state onto the other. This definition gives sensible results for simple, analytically tractable cases and is consistent with a previous definition restricted to Greenberger-Horne-Zeilinger-like states. We apply our measure to the experimentally relevant, nontrivial example of a superconducting three-junction flux qubit put into a superposition of left- and right-circulating supercurrent states and find this Schrödinger cat to be surprisingly small.

Reference: quant-ph/0609007

TT 28.33 Thu 14:00 Poster A

Anomalous stability diagram in double-walled carbon nanotube quantum — •Shidong Wang, Emiliano Pallecchi, Christoph Strunk, and Milena Grifoni — Institut fuer Theoretische Physik, Universität Regensburg

We investigate a quantum dot system formed by a double-walled carbon nanotube in the Coulomb blockade regime. We show that the system can be mapped into a capacitively connected double quantum dot system. The two quantum dots are connected in parallel and have different charging energies and different energy-dependent couplings with leads. We calculate the stability diagram of this system by using the master equation approach. The diagram shows the superposition of two sets of diamond patterns with different size, as it has been recently observed in transport experiments across multi-walled carbon nanotubes.

TT 28.34 Thu 14:00 Poster A

Full Counting Statistics from quantum trajectories — •Ansgar Pernice[1] and Walter Strunz[2] — [1]Physikalisches Institut der Universität Freiburg, Herrmann-Herder-Str. 3,79104 Freiburg, Germany — [2]Physikalisches Institut der Universität Freiburg, Herrmann-Herder-Str. 3,79104 Freiburg, Germany

Motivated by a recent experiment [1], we apply a quantum trajectory approach to the determination of the full counting statistics (FCS)of single-electron transport in a quantum dot.

The FCS reveals information about the initial state of the dot [2]. In the case of the steady state, our results coincide with the formulae given by Bagrets and Nazarov [3]. However, the FCS differs in the case of an initially full/empty dot and for short times.

Last but not least, we establish the connection between our approach and those based on counting fields in providing a new deriviation of the quantum-jump-representation, here for a fermionic environment.

[1] S. Gustavsson, R. Leturcq, B. Simovic, R. Schleser, T. Ihn, P. Studerus, and K. Ensslin, Phys. Rev. 96, 076605 (2006)
[2] H. Schaefers and W. T. Strunz, Phys. Rev. B 71, 075321 (2005).
[3] D. A. Bagrets and Yu. V. Nazarov, Phys. Rev. B 67, 085316 (2003).

TT 28.35 Thu 14:00 Poster A

Full Counting Statistics from quantum trajectories — •Ansgar Pernice[1] and Walter Strunz[2] — [1]Physikalisches Institut der Universität Freiburg, Herrmann-Herder-Str. 3,79104 Freiburg, Germany — [2]Physikalisches Institut der Universität Freiburg, Herrmann-Herder-Str. 3,79104 Freiburg, Germany

Motivated by a recent experiment [1], we apply a quantum trajectory approach to the determination of the full counting statistics (FCS)of single-electron transport in a quantum dot.

The FCS reveals information about the initial state of the dot [2]. In the case of the steady state, our results coincide with the formulae

given by Bagrets and Nazarov [3]. However, the FCS differs in the case of an initially full/empty dot and for short times.

Last but not least, we establish the connection between our approach and those based on counting fields in providing a new deriviation of the quantum-jump-representation, here for a fermionic environment.

[1] S. Gustavsson, R. Leturcq, B. Simovic, R. Schleser, T. Ihn, P. Studerus, and K. Ensslin, Phys. Rev. Let. 96, 076605 (2006)

[2] H. Schaefers and W. T. Strunz, Phys. Rev. B 71, 075321 (2005).

[3] D. A. Bagrets and Yu. V. Nazarov, Phys. Rev. B 67, 085316 (2003).

TT 28.36 Thu 14:00 Poster A

Charge and spin transport in double quantum dot systems — •Georg Begemann, Ralph Peter Hornberger, Andrea Donarini, and Milena Grifoni — Universität Regensburg, Theoretische Physik

We consider spin and charge transport through two quantum dots in series, described by an extended Hubbard Hamiltonian. This model Hamiltonian describes conjugated molecules as well. Unpolarized as well as spin-polarized leads are considered. We calculate physical quantities like the conductance or the average spin using two different approaches.

On one side we start from a Liouville equation approach for the system density matrix and calculate I-V-V_g characteristics perturbatively in the tunneling.

On the other hand we evaluate the Green's functions of the interacting systems using the equation of motion technique, which allows a nonperturbative treatment of the coupling. To this extent we generalize the approximation by Meir, Wingreen and Lee [1] for the single-site to the two-site case.

[1] Y. Meir, N. S. Wingreen and P. A. Lee: Transport through a Strongly Interacting Electron System: Theory of Periodic Conductance Oscillations, Phys. Rev. Lett. 66, 3048 (1991)

TT 28.37 Thu 14:00 Poster A

Spin-dependent transport in carbon nanotube quantum dots — •Sonja Koller, Leonhard Mayrhofer, and Milena Grifoni — Universität Regensburg

We have theoretically studied spin-dependent transport across low transparently contacted interacting metallic single wall carbon nanotubes. The contacts are assumed to be magnetic with arbitrary magnetisation directions. In the low bias voltage regime, a current flow is either allowed by resonant tunnelling or Coulomb blocked. We could show how the current at the resonance peaks is influenced by the contact magnetisations and give the evolution of the tunnelling magnetoresistance with both the gate voltage and the relative polarisations. In the case of exact parallel or antiparalllel polarisations, the current follows a simple analytical law. The ratio of parallel to antiparallel current merely depends on the polarisation strength and the asymmetry of the leads.

TT 28.38 Thu 14:00 Poster A

Collective charge and spin excitations in interacting 2DEG with spin-orbit coupling — •Sergej Konschuh and Mikhail Pletyukhov — Institut für Theoretische Festkörperphysik, Universität Karlsruhe, D-76128 Karlsruhe, Germany

We present the analytic expressions for the charge and spin density response functions of the two-dimensional electron gas (2DEG) with Rashba spin-orbit (SO) coupling. Taking into account the Coulomb interaction in the random phase approximation (RPA), we study the dispersions of the collective charge and spin-polarization modes. Special attention is devoted to the role of the spin-charge mixing in the density matrix response function.

TT 28.39 Thu 14:00 Poster A

Rectification effects in quantum transport through single aromatic molecules — •Florian Pump, Bo Song, Dmitry Ryndyk, and Gianaurelio Cuniberti — Institute for Theoretical Physics, University of Regensburg, D-93040 Regensburg, Germany.

The signatures of truly molecular mediated quantum transport in single molecule experiments have to be selectively identified and often their theoretical mechanisms still need to be understood. We investigated the behavior of a donor-acceptor molecular junction in the coherent regime using a model Hamiltonian [1] as well as density functional based nonequilibrium transport calculations [2]. Additionally, we studied the system in the situation of weak coupling to the leads where charging effects do play an important role and we could show that the intrinsic energetic asymmetry of a donor-acceptor molecule remains responsible for the rectification effects even in the Coulomb blockade regime [3]. Contact to the experiments by Elbing *et al.* [4] is also provided.

[1] F. Pump and G. Cuniberti, `cond-mat/0611436`.

[2] F. Pump *et al.*, in preparation.

[3] B. Song, D. Ryndyk, and G. Cuniberti, `cond-mat/0611190`.

[4] M. Elbing *et al.*, Proc. Natl. Acad. Sci. USA **102**, 8815 (2005).

TT 28.40 Thu 14:00 Poster A

Spin-polarized tunneling currents through magnetic layer systems — •Niko Sandschneider and Wolfgang Nolting — Humboldt-Universität zu Berlin, Institut für Physik, Newtonstr. 15, 12489 Berlin, Germany

Using the Keldysh formalism we calculate the tunneling currents through a hybrid structure where a confined magnetic insulator (I) is sandwiched between two leads. They can be either normal metals (M) or superconductors(S) (M/I/M, M/I/S, S/I/S). The insulator is assumed to have localized moments which can interact with the tunneling electrons. This is described by the Kondo lattice model (KLM) and treated within an interpolating self-energy approach. For the superconductor we used the mean-field BCS theory. We also propose an effective medium approximation for the M/I/S and S/I/S systems.

By deriving a current formula it is possible to calculate the voltage-dependent tunneling current in a self-consistent way. It is shown that the current is always spin-polarized and that the degree of polarization depends on the applied voltage and the parameters of the materials. In M/I/M systems it is not possible to get a spin polarization high enough for technological applications.

The experimental results of [1] can be reproduced qualitatively. It is also possible to determine optimal parameters for high spin polarization in the systems under consideration.

[1] X. Hao, J.S. Moodera and R. Meservey, Phys. Rev. B 42, 8235 (1990)

TT 28.41 Thu 14:00 Poster A

Ballistic magnetoresistance in Ni nanocontacts — •Steven Walczak, Michael Czerner, and Ingrid Mertig — Institute of Physics, Martin Luther University Halle-Wittenberg, Germany

During the last years the ballistic magnetoresistance of nickel (Ni) single-atom contacts has been measured in various of experiments. Recently, Sullivan *et al.* [1] reported about extraordinary large magnetoresistance in Ni nanocontacts. These experimental observations are still in contradiction to other experimental [2] and theoretical results in the coherent limit of transport [3].

Ab initio calculations of the electronic structure and transport properties of magnetic nanocontacts of Ni will be presented. The electronic structure of these nanocontacts is calculated self-consistently in the framework of the density functional theory by means of the Korringa-Kohn-Rostoker method. The transport properties are described in the linear response regime based on the Landauer approach in the formulation of Baranger and Stone [4].

This contribution aims to explain the change of the conductance values in dependence on strain and compression for a single-atom contact, the influence of the symmetry for small Ni clusters, and the effect of an external magnetic field on a magnetic Ni particle in the contact region.

[1] M. R. Sullivan *et al.*, Phys. Rev. B **71**, 024412 (2005)

[2] M. Viret *et al.*, Phys. Rev. B **66**, 220401(R) (2002)

[3] A. Bagrets *et al.*, cond-mat/0510073 (2005)

[4] H. U. Baranger and A. D. Stone, Phys. Rev. B **40**, 8169 (1989)

TT 28.42 Thu 14:00 Poster A

Influence of spin waves on the transport through a quantum-dot spin valve — •Björn Sothmann[1], Jürgen König[1], and Anatoli Kadigrobov[1,2] — [1]Theoretische Physik III, Ruhr-Universität Bochum, D-44780 Bochum — [2]Department of Physics, Göteborg University, SE-412 96 Göteborg

We study transport through a quantum-dot spin valve, i.e. a single-level quantum dot with strong Coulomb interaction weakly coupled to ferromagnetic leads with non-collinear magnetizations. When a bias voltage is applied, a spin is accumulated on the dot leading to a reduction of the conductance. The Coloumb interaction leads to a spin precession which can be described in terms of an exchange field. In the linear transport regime this exchange field gives rise to a reduction of the spin-valve effect while in the non-linear regime it yields a negative differential conductance.

In Ref. [1] a real-time diagrammatic technique was developed to describe transport through quantum-dot spin valves. We extend this theory by taking into account the effect of spin waves induced in the leads. We deduce kinetic equations for the dot's occupation, its spin and the number of excited spin waves. These are used to compute the transport properties in the linear and non-linear transport regime.
[1] M. Braun, J. König, J. Martinek, Phys. Rev. B **70**, 195345 (2004)

TT 28.43 Thu 14:00 Poster A

Magnetoconductance of the Oval — Daniel Buchholz[1] and •Peter Schmelcher[1,2] — [1]Theoretische Chemie, Institut für Physikalische Chemie, Universität Heidelberg, INF 229, 69120 Heidelberg — [2]Physikalisches Institut, Universität Heidelberg, Philosophenweg 12, 69120 Heidelberg

We have calculated the ballistic quantum conductance of an open, two-dimensional, oval-shaped quantum dot with hard-wall boundary conditions using the Landauer-Büttiker formalism. The conductance depends on the deformation parameter of the oval: In the absence of magnetic fields, the temperature-averaged conductance is strongly suppressed inside an energy window covering one fourth of the first channel. A relatively weak perpendicular magnetic field raises the conductance to its maximal value.

TT 28.44 Thu 14:00 Poster A

Current induced motion of a domain wall — •Christian Wickles and Wolfgang Belzig — Fachbereich Physik, Universität Konstanz

A quantum Boltzman approach within the framework of a mean field Stoner model is employed to study the spin-current induced motion of domain walls in ferromagnetic materials. The local magnetisation of the ferromagnet is described by an exchange field with space- and time-dependent direction. The effect of magnetic impurity and spin-orbit scattering is considered. Non-adiabaticity terms are included aswell.

TT 28.45 Thu 14:00 Poster A

Spin-orbit based ratchets for spin-polarized currents — •Manuel Strehl[1], Matthias Scheid[1], Dario Bercioux[1,2], and Klaus Richter[1] — [1]Institut für Theoretische Physik, Universität Regensburg, Germany — [2]Physikalisches Institut, Albert-Ludwigs-Universität, Freiburg, Germany

Spin-quantum ratchets are a new class of ratchet devices that can give rise to spin currents. The minimal setup for the spin ratchet is given by the combination of spin-orbit interaction in a coherent quantum wire with a spatially periodic electrostatic potential.

Upon external ac-driving, and in the absence of a static bias, the system generates a directed spin current, while the total charge current is zero.

We analyze the underlying mechanism by combining symmetry properties of the scattering matrix and a Landau-Zener approach for evaluating the probability of the spin flipping, and we numerically verify the effect for different setups relevant for experiment. We further show that the spin current directions can be changed upon tuning the injection energy or the relative strength of Rashba and Dresselhaus spin-orbit coupling. In addition, also the dependences of the spin current as a function of the direction of the wire with respect to the crystallographic axes is considered.

TT 28.46 Thu 14:00 Poster A

Dissipative spin-rectifiers — •Sergey Smirnov[1], Dario Bercioux[1,2], Klaus Richter[1], and Milena Grifoni[1] — [1]Institut für Theoretische Physik, Universität Regensburg, Germany — [2]Physikalisches Institut, Albert-Ludwigs-Universität, Freiburg, Germany

In this contribution we analyze the possibility to generate, due to the presence of spin-orbit coupling, spin-currents in periodic structures subject to unbiased forcing in presence of coupling to a thermanl environment. So far the coherent regime was investigated [1]. As a model we consider a quasi-one-dimensional system where an electron is subjected to a periodic potential in the longitudinal direction, and with two modes only contributing from the confinement potential in the transverse direction. Only the lowest energy band of the longitudinal periodic potential is considered. Environmental effects are described by a bath of harmonic excitations bilinearly coupled to the particle position. Dissipation effects on the spin dynamics thus originate via the spin-orbit coupling. All the calculations are done in the framework of the real-time path integral technique. We show how the spin-current can be conveniently calculated in the generalization of the so-called discrete variable representation [2], which is the basis which diagonalizes the spin-current operator.

[1] M. Scheid, A. Pfund, D. Bercioux, and K. Richter cond-mat/0601118.

[2] M. Grifoni, M.S. Ferreira, J. Peguiron and J.B. Majer, Phys. Rev. Lett. 89, 146801 (2002).

TT 28.47 Thu 14:00 Poster A

Fingerprints of the magnetic polaron in nonequilibrium electron transport through a quantum wire coupled to a ferromagnetic spin chain — •Frank Reininghaus, Thomas Korb, and Herbert Schoeller — Institut für Theoretische Physik A, RWTH Aachen, 52056 Aachen, Germany

We study nonequilibrium quantum transport through a mesoscopic wire coupled via local exchange to a ferromagnetic spin chain [1]. Using the Keldysh formalism in self-consistent Born approximation, we identify fingerprints of the magnetic polaron state formed by hybridization of electronic and magnon states. Due to its low decoherence rate, we find coherent transport signals. Both elastic and inelastic peaks of the differential conductance are discussed as function of external magnetic fields, the polarization of the leads and the electronic level spacing of the wire.
[1] F. Reininghaus, T. Korb, and H. Schoeller, Phys. Rev. Lett. **97**, 026803 (2006)

TT 28.48 Thu 14:00 Poster A

Transport in Nanomechanical Nonlinear Oscillators — •Hannes Huebener[1] and Tobias Brandes[2] — [1]I. Institut für Theoretische Physik, Universität Hamburg — [2]Institut für Theoretische Physik, TU Berlin

We solve the model of a nanomechanical oscillator in the nonlinear potential created by the image charges of an additional transport electron. This system shows level anticrossing in the eigenvalue spectrum as a function of its frequency. We use the Franck-Condon principle to calculate the transition rates from leads to the oscillator. Under damping conditions we find rich behaviour even in a two-level approximation. We present results for transport properties of the system based on Master equations and Wigner function representations.

TT 28.49 Thu 14:00 Poster A

Charge Transfer along molecular chains: Quantum Monte Carlo simulations, rate equations and steady state currents — •Charlotte Escher[1], Lothar Mühlbacher[2], and Joachim Ankerhold[1] — [1]Physikalisches Institut, Albert-Ludwigs-Universität Freiburg — [2]School of Chemistry, Tel Aviv University, Israel

Based on a path integral Monte Carlo approach we investigate the real-time dynamics of single and correlated charge transfer along molecular chains interacting with vibronic and/or solvent environments. We identify regions in parameter space, where sequential hopping influenced by tunneling of collective vibronic modes allows for an accurate rate description of the full dynamics. In case of correlated transfer symmetries in the charge-vibron coupling lead to invariant subspaces in which entangled states do not equilibrate. Results for isolated molecular chains are extended to calculate the voltage dependence of the steady state currents through molecular wires between two conducting leads.

TT 28.50 Thu 14:00 Poster A

Spin-boson dynamics in a structured environment: A path integral approach — •Johannes Hausinger, Francesco Nesi, and Milena Grifoni — Universität Regensburg

In our work we examine the dynamics of a spin-boson Hamiltonian coupled to a reservoir featuring a peaked spectral density.This system has become relevant to investigate e. g. relaxation and dephasing in flux qubits coupled to a dc-SQUID detector [1].

We investigate that system using the real-time path integral approach of Feynman and Vernon.

We consider the case of a symmetric as well as of a biased two-level system (TLS). In the symmetric case the so-called noninteracting-blip approximation (NIBA), being perturbative in the tunneling coupling Δ, well describes the TLS dynamics. In particular the related power spectrum exhibits Rabi-vacuum splitting in the proper parameter regime. In the biased case however, the NIBA fails [2] in the low temperature and damping regime.

We present a novel approximation scheme capable to deal with bath-

induced correlations in such a low temperature regime.
[1] M. Thorwart, E. Paladino, M. Grifoni, Chem. Phys. 296, 333 (2004)
[2] U. Weiss, *Quantum Dissipative Systems*, 2nd ed. (World Scientific, Singapore, 1999)

TT 28.51 Thu 14:00 Poster A

Break junction tunnel spectroscopy in the hopping regime — •Barbara Sandow[1], Dirk Brossell[1], Olaf Bleibaum[2], and Walter Schirmacher[3] — [1]Institut für Experimentalphysik, Freie Universität Berlin — [2]Institut für Theoretische Physik, Otto-von-Gericke Universität Magdeburg — [3]Physic Department E13, Technische Universität München

Break junction tunnel spectroscopy is a tradtional method for investigating the electronic structure of solids. In weakly doped semiconductors in the hopping regime the spectra cannot be interpreted by means of Bardeen's [1] theory, because it is based on a metallic conduction mechanism. We have formulated a new ansatz [2] for the tunnel current in the hopping regime. Using our new theory we are able to interpret data which exhibit the Coulomb gap in a satisfactory way. The dependence of the gap width on temperature and carrier concentration is discussed in terms of current theories of the Coulomb gap.

1 J. Bardeen, Phys. Rev. Lett. 6, 75 (1961) 2 O. Bleibaum, B. Sandow, W. Schirmacher, Phys. Rev. B 70, 045308-1 (2004)

TT 28.52 Thu 14:00 Poster A

Probing Spin Precession by Noise Spectroscopy — •Matthias Braun[1], Jürgen König[1], and Jan Martinek[2] — [1]TPIII, Ruhr-Universität Bochum, 44780 Bochum, Germany — [2]IMP, Polish Academy of Science, 60-179 Poznań, Poland

We theoretically discuss the possibility to observe electron-spin precession by its imprint on the noise spectrum of a reference quantity. A finite-frequency noise measurement of this reference quantity can therefore be used as unorthodox electron-spin resonance experiment. We review two different systems illustrating this idea.
1.) In a single-level quantum dot with ferromagnetic leads, the spin noise is mapped on the current noise by tunnel magnetoresistance [1]. The current-noise frequency spectrum then reveals Larmor frequency and spin life time of the conduction electrons. This transport experiment is therefore equivalent to a single spin cw-ESR experiment.
2.) By sending laser light through selected semiconductor [2] or gas [3] samples, one can observe a Faraday rotation of the polarization plane. In addition, the spin fluctuations in the sample also lead to fluctuations of the Faraday rotation. These fluctuations can again be measured, and used as ESR experiment. It is even possible to realize Faraday-rotation fluctuation experiments, which avoid some sources of inhomogeneous line broadening [4].
[1] M. Braun *et al.*, Phys. Rev. B **74**, 075328 (2006).
[2] M. Oestreich *et al.*, Phys. Rev. Lett. **95**, 216603 (2005).
[3] S. A. Crooker *et al.*, Nature **431**, 49 (2004).
[4] M. Braun *et al.*, cond-mat/0601607.

TT 28.53 Thu 14:00 Poster A

Functional renormalization group for nonequilibrium quantum many-body problems — •Riccardo Gezzi, Thomas Pruschke, and Volker Meden — Institut für theoretische Physik Friedrich-Hund-Platz 1 37077 Göttingen

We extend the concept of the functional renormalization for quantum many-body problems to non-equilibrium situations. Using a suitable generating functional based on the Keldysh approach, we derive a system of coupled differential equations for the m-particle vertex functions. The approach is completely general and allows calculations for both stationary and time-dependent situations. As a specific example we study the stationary state transport through a quantum dot with local Coulomb correlations at finite bias voltage employing two different truncation schemes for the infinite hierarchy of equations arising in the functional renormalization group scheme.

TT 28.54 Thu 14:00 Poster A

Mesoscopic to universal crossover of transmission phase of multi-level quantum dots — •Christoph Karrasch[1], Theresa Hecht[2], Yuval Oreg[3], Jan von Delft[2], and Volker Meden[1] — [1]Institut für Theoretische Physik, Göttingen, Germany — [2]Physics Department, Ludwig-Maximilians-Universität, Munich, Germany — [3]Department of Condensed Matter Physics, The Weizmann Institute of Science, Rehovot, Israel

Transmission phase α measurements [1] of many-electron quantum dots (small mean level spacing δ) revealed universal phase lapses by π between consecutive resonances. In contrast, for dots with only a few electrons (large δ), the appearance or not of a phase lapse depends on the dot parameters. We introduce a model of a multi-level quantum dot with local Coulomb correlations and arbitrary level-lead couplings [2]. Using the functional RG to tackle the two-particle interaction we reproduce the generic features of the experimentally observed behavior. The fRG results are backed up by NRG calculations.

[1] M. Avinun-Kalish, M. Heiblum, O. Zarchin, D. Mahalu, and V. Umansky, Nature **436**, 529 (2005).
[2] C. Karrasch, T. Hecht, Y. Oreg, J. von Delft, and V. Meden (2006), cond-mat/0609191

TT 28.55 Thu 14:00 Poster A

Temperature induced phase averaging in one-dimensional mesoscopic systems — •Severin Jakobs[1], Volker Meden[2], Herbert Schoeller[1], and Tilman Enss[3] — [1]Institut für Theoretische Physik A, RWTH Aachen, Germany — [2]Institut für Theoretische Physik, Universität Göttingen, Germany — [3]Dipartimento di Fisica, Università di Roma "La Sapienza", Italy

We analyse phase averaging in one-dimensional interacting mesoscopic systems with several barriers and show that for incommensurate positions an independent average over several phases can be induced by finite temperature [1]. For three strong barriers with conductances G_i and mutual distances larger than the thermal length, we obtain $G \sim \sqrt{G_1 G_2 G_3}$ for the total conductance G. For an interacting wire, this implies power laws in $G(T)$ with novel exponents, which we propose as an experimental fingerprint to distinguish temperature induced phase averaging from dephasing.

[1] S. Jakobs, V. Meden, H. Schoeller, T. Enss, cond-mat/0606486

TT 29: Superconductivity - Mechanisms, Phase Diagram, Competing Order

Time: Thursday 16:00–17:45 Location: H18

TT 29.1 Thu 16:00 H18

From stripe to checkerboard charge order in the presence of a random potential — •Bernd Rosenow, Adrian Del Maestro, and Subir Sachdev — Department of Physics, Harvard University,Cambridge, Massachusetts 02138, USA

We discuss the effects of quenched disorder on a model of charge density wave (CDW) ordering on the square lattice. Our model may be applicable to the cuprate superconductors, where a random electrostatic potential exists in the CuO_2 planes as a result of the presence of charged dopants. We argue that the presence of a random potential can affect the unidirectionality of the CDW order, characterized by an Ising order parameter. Coupling to a unidirectional CDW, the random potential can lead to the formation of domains with 90 degree relative orientation, thus tending to restore the rotational symmetry of the underlying lattice. We find that the correlation length of the Ising order can be significantly larger than the CDW correlation length. For a checkerboard CDW on the other hand, disorder generates spatial anisotropies on short length scales and thus some degree of unidirectionality. We quantify these disorder effects and suggest techniques for analyzing the spatially dependent local density of states data measured in scanning tunneling microscopy experiments.

[1] A. Del Maestro, B. Rosenow, and S. Sachdev, Phys. Rev. B 74, 024520 (2006).

TT 29.2 Thu 16:15 H18

Tunneling spectroscopy of the electron doped high-temperature superconductor $La_{2-x}Ce_xCuO_4$ — •Michael Wagenknecht[1], Markus Turad[1], Dieter Koelle[1], Reinhold Kleiner[1], Siegfried Graser[2], Nils Schopohl[2], Akio Tsukada[3], and Michio Naito[4] — [1]Universität Tübingen, Experimentalphysik II,

Auf der Morgenstelle 14, D-72076 Tübingen, Germany — [2]Universität Tübingen, Lehrstuhl für Theoretische Festkörperphysik, Auf der Morgenstelle 14, 72076 Tübingen, Germany — [3]NTT Basic Research Laboratories, Atsugi-shi, Japan — [4]Department of Applied Physics, Tokyo University of Agriculture and Technology, Tokyo, Japan

We show tunnel spectroscopy data of quasiparticle transport in electron doped high-temperature superconductor (HTS) $La_{2-x}Ce_xCuO_4$ bicrystal thin films with a 24° symmetric [001]-tilt grain boundary patterned as Josephson junction SQUIDs ($x \sim 0.08$, slightly underdoped with $T_c \sim 28$ K). The differential conductance in the superconducting state shows a zero bias conductance anomaly (ZBCA), which is attributed to surface Andreev bound states at zero excitation energy due to d-wave symmetry of the order parameter in this electron doped HTS. As the ZBCA is related to the macroscopic phase coherence of the superconducting state it vanishes at T_c in zero field. However, with applied field we observe a persistent ZBCA up to at least 10 T. This is in contradiction to previously reported values of $B_{c2}(0) \sim 7$ T based on $\rho(T)$ measurements. Supported by calculations taking into account the effect of the vortex lattice we suggest a modified $B(T)$ phase diagram with a higher $B_{c2} > 10$ T.

TT 29.3 Thu 16:30 H18

Dynamical spin susceptilibility and the resonance peak in the electron-doped cuprate superconductors — •Jan-Peter Ismer[1,2], Ilya Eremin[1,2], and Dirk Morr[3] — [1]Max-Planck Institut für Physik komplexer Systeme, D-01187 Dresden, Germany — [2]Insitute für Mathematische und Theoretische Physik, Technische Universitaet Carola-Wilhelmina zu Braunschweig, 38106 Braunschweig, Germany — [3]Department of Physics, University of Illinois at Chicago, Chicago, IL 60607

We present a study of the dynamical spin susceptibility in the electron-doped cuprate superconductors. We show that the resonance peak observed recently in $Pr_{0.88}LaCe_{0.12}CuO_{4-\delta}$ represents rather an effect of the magnetic coherence than a bound state seen in the hole-doped counterparts. We further analyze some aspects of the peculiar behavior of the spin excitations in the presence of the spin density wave (SDW) instability in $d_{x^2-y^2}$-wave superconducting state ($T_N << T_C$). We find that the spin resonance will show a remarkable temperature dependence in contrast to the hole-doped cuprates. Furthermore we investigate the influence of a Zeeman-magnetic field on the resonance.

TT 29.4 Thu 16:45 H18

Theory for orthorhombic distortions in high-T_c cuprates — •Dirk Manske[1], Andreas Schnyder[2], Julia Unterhinninghofen[1], and Manfred Sigrist[2] — [1]Max-Planck-Institut für Festkörperforschung, Stuttgart — [2]Institut für Theoretische Physik, ETH Zürich

We re-investigate the theoretical description of inelastic neutron scattering data on detwinned YBCO (Hinkov *et al.*, Nature 2004) and compare our results with LDA calculation as well as recent ARPES results. We find fair agreement within a Fermi-liquid-based approach. Using this approach, we also study the polarization-dependent electronic Raman response of untwinned high-Tc superconductors employing a tight-binding band structure with anisotropic hopping matrix parameters and a superconducting gap with a mixing of d- and s-wave symmetry. Using general arguments we find new screening terms in the B_{1g} scattering channel which are required by gauge invariance. As a result, we find a small but measurable softening of the pair-breaking peak, whose position has been attributed for a long time to twice the superconducting gap maximum. Our results are contrasted to the stripe scenario proposed for the high-T_c cuprates.

TT 29.5 Thu 17:00 H18

Raman study of underdoped $Y_{1-y}Ca_yBa_2Cu_3O_{6+x}$ — •Leonardo Tassini, Wolfgang Prestel, Rudi Hackl, Andreas Erb, and Michael Lambacher — Walther Meissner Institut, Bayerische Akademie der Wissenschaften, 85748 Garching, Germany

The electronic Raman effect has been studied in several $Y_{1-y}Ca_yBa_2Cu_3O_{6+x}$ (Y-123) single crystals, in the doping range $0 \leq p \leq 0.07$. The temperature, doping and polarization dependence of phonons, magnons, and the electronic continuum were investigated. All types of excitations vary continuously with temperature and doping up to $p \approx 0.06$ where superconductivity sets in. Above this doping level discontinuous changes of the spectra are found at all energies and temperatures highlighting the importance of strong correlations. The results provide evidence of a strongly **k**-dependent interaction becoming effective above $p \approx 0.06$.

The project has been supported by the DFG under grant number Ha2071/3-1 via the Research Unit FOR 538.

TT 29.6 Thu 17:15 H18

Nernst Effect in $NdBa_2\{Cu_{1-y}Ni_y\}_3O_{7-\delta}$ — •Niko Johannsen[1], Thomas Wolf[2], Thomas Lorenz[1], and John Mydosh[1] — [1]II Physikalisches Institut, Universität zu Köln, Zülpicher Str. 77, 50937 Köln — [2]Forschungszentrum Karlruhe, IFP, 76021 Karlsruhe

More than 20 years after its discovery the mechanism of high-temperature superconductivity is still unsolved. Possible relations to other anomalous phenomena in High-T_c materials such as the pseudogap may play a key role towards an understanding of this mechanism. The Nernst effect is an excellent probe to detect vortices and vortex-like excitations[1]. In $NdBa_2\{Cu_{1-y}Ni_y\}_3O_{7-\delta}$, adding magnetic Ni-impurities leads to a suppression of T_c but at the same time the pseudogap is strongly enhanced[2]. So this is an ideal system to study possible relations between superconductivity and the pseudogap. We present measurements on a series of optimally doped (O_7) and underdoped ($O_{6.8}$) samples with Ni contents ranging from y=0 to 0.12. In all samples an onset of the Nernst signal (T^ν) can be found above T_c. T^ν decreases with increasing Ni content as does T_c for the optimally doped samples. The underdoped samples show a slightly different behaviour. The onset of the Nernst signal is not affected when increasing the Ni content from y=0 to 0.03.

Supported by the DFG through SFB 608.

[1] Wang et al., PRB 73, 024510 (2006)
[2] Pimenov et al., PRL 94, 227003 (2005)

TT 29.7 Thu 17:30 H18

^{63,65}Cu Nuclear Quadrupole Resonance Study of Impurity doped $NdBa_2(Cu,Ni,Zn)_3O_{6+y}$ — •Hans-Joachim Grafe[1], Franziska Hammerath[1], Anastasia Vyalikh[1], Grzegorz Urbanik[1], Vladislav Kataev[1], Thomas Wolf[2], and Bernd Büchner[1] — [1]IFW Dresden, Institut für Festkörperforschung, Postfach 270116, 01171 Dresden, Germany — [2]Forschungszentrum Karlsruhe, IFP, D-76021 Karlsruhe, Germany

We present ^{63,65}Cu Nuclear Quadrupole Resonance (NQR) measurements on slightly underdoped $NdBa_2(Cu,Ni,Zn)_3O_{6+y}$ single crystals with 11.5 % magnetic (Ni) and 12 % non-magnetic (Zn) impurities. Superconductivity is completely suppressed in both samples. By fitting the spectra we can estimate the impurity content of the chains and the planes. At low temperatures the Ni induces a wipeout of the Cu NQR signal intensity comparable to that found in stripe ordered lanthanum cuprates. In contrast, the intensity of the Zn doped sample is not changed down to the lowest temperatures, and the spin lattice relaxation rate is suppressed. This difference enlightens the different effect of nonmagnetic ($S = 0$) and magnetic ($S = 1$) impurities on the spin dynamics in the CuO_2 planes, and directly confirms current theoretical positions on this topic.

TT 30: Superconductivity - Cryodetectors

Time: Thursday 17:00–19:00 Location: H20

TT 30.1 Thu 17:00 H20

Development of magnetic calorimeters with superconducting Re absorber for ν mass experiments — •L. Gastaldo, J.-P. Porst, S. Schaefer, M. Linck, A. Burck, S. Kempf, H. Rotzinger, A. Fleischmann, and C. Enss — Kirchhoff-Institut fuer Physik, Universitaet Heidelberg, INF 227, D-69120 Heidelberg, Germany

Direct measurement of ν_e mass is in principle possible by the analysis of the end point of β-spectra. Presently two different approaches are followed: the measurement of the tritium β-spectrum using a new generation mass spectrometer by the KATRIN (KArlsruhe TRItium Neutrino) experiment and the calorimetric detection of electrons from ^{187}Re proposed in MARE (Microcalorimeters Array for a Rhenium Experiment). The MARE detectors are micro-calorimeters running below 100 mK. They are composed by a superconducting rhenium absorber/source, in which the β-events release the energy, and a thermal sensor reading out the temperature variation. Currently TESs (Transition Edge Sensors) and MMCs (Metallic Magnetic Calorimeters) are expected to meet the requirements in term of energy resolution and time constants. We developed MMCs with single crystal Re absorber and paramagnetic Au:Er temperature sensor which are read by SQUIDs with meander shaped sensing inductance. This geometry minimizes the magnetic field in the region of the superconducting absorber and this keeps the trapped flux lines on a negligible level. A detailed analysis of the effects due to the superconducting rhenium absorber is reported, focusing on the influence that superconductive state can have on the detector response.

TT 30.2 Thu 17:15 H20

Microfabricated magnetic calorimeter with meander shaped pickup coil — •A. Burck, S. Kempf, M. Linck, H. Rotzinger, S. Schäfer, J. Porst, T. Wolf, A. Fleischmann, L. Gastaldo, and C. Enss — Kirchhoff-Institut für Physik, Heidelberg, Germany

Metallic magnetic calorimeters (MMC) combine the high spectral resolution of crystal spectrometer and the high quantum efficiency of solid state spectrometer. Recently we demonstrated an energy resolution of 2.7 eV for 6 keV photons. This makes MMCs a promising and powerful tool for many applications where photons or energetic massive particles have to be detected. However, in order to fulfill all requirements of these applications and to allow to reach the maximum resolving power a consequent microfabrication of the MMC detectors is needed.

We present our first fully microfabricated MMC which consists of an absorber, a 3 μm thick sputter deposited paramagnetic AuEr temperature sensor and a meander shaped niobium thin film pickup coil. Deposition of energy in the absorber causes a rise in temperature and results in a change of magnetisation of the paramagnetic sensor which is measured by a low noise high bandwidth dc-SQUID. By using a new optimized persistent current switch a large field current can be frozen in the pickup coil which produces an inhomogeneous magnetic field within the volume of the sensor. The sputter deposited AuEr films we report on are working well and show the properties of bulk material. The performance of our MMCs with such films agree well with the numerically simulated behavior.

TT 30.3 Thu 17:30 H20

Detectors for Calibration Measurements in CRESST — •Wolfgang Westphal, Christian Ciemniak, Chiara Coppi, Franz von Feilitzsch, Achim Gütlein, Christian Isaila, Jean-Côme Lanfranchi, Sebastian Pfister, Walter Potzel, Wolfgang Rau, Sabine Roth, and Michael Stark — Physik-Department E15, Technische Universität München, James-Franck-Straße, 85748 Garching

The CRESST (=Cryogenic Rare Event Search with Superconducting Thermometers) experiment searches for dark matter particles (Weakly Interacting Massive Particles, WIMPs) via nuclear scattering using cryogenic detectors. The simultaneous measurement of the phonon signal and the scintillation light from the target $CaWO_4$ crystal allows to veto effectively background from βs and γs due to the different light output for electron and nuclear recoils. At the TU München we are performing calibration measurements for the better understanding of the detector response to various event types (e.g. neutrons scattering on different nuclei). For this purpose we are developing a special version of the CRESST detector optimized for higher count rates. These detectors consist of a smaller $CaWO_4$ crystal (10 – 38 g instead of 300 g) together with a cryogenic light detector, both equipped with Ir/Au transition edge sensors. We will report on the latest results of these developments. This work has been supported by funds of the DFG (SFB 375, Transregio 27: Neutrinos and Beyond), the Munich Cluster of Excellence (Origin and Structure of the Universe) and the Maier-Leibnitz-Laboratorium (Garching).

TT 30.4 Thu 17:45 H20

Optimization of the Czochralski Growth Process for $CaWO_4$ Detector Crystals — •Christian Ciemniak[1], Chiara Coppi[1], Andreas Erb[2,3], Franz von Feilitzsch[1], Christian Isaila[1], Jean-Côme Lanfranchi[1], Sebastian Pfister[1], Walter Potzel[1], Wolfgang Rau[1], Sabine Roth[1], and Wolfgang Westphal[1] — [1]Physikdepartment E15, Technische Universität München, James-Franck-Straße, 85748 Garching — [2]Walther-Meißner-Institut, Walther-Meißner-Straße 8, 85748 Garching — [3]Kristallabor, Technische Universität München, James-Franck-Straße, 85748 Garching

CRESST is an experiment for the direct detection of dark matter (WIMPs). The expected very low event rates and the low energy transfer in the keV range demand low background rates and sensitive detectors. Thus the need for detector crystals with good optical and phonon properties combined with high radioactive purity arises. To achieve these goals, the control over the raw materials and their processing, in particular the crystal growth, are important. In an ongoing effort at the Physikdepartment E15, the Czochralski Growth Process of $CaWO_4$ detector crystals is optimized to meet these requirements. We report on first results.

This work has been supported by funds of the DFG (SFB 375, Transregio 27: Neutrinos and Beyond), the Munich Cluster of Excellence (Origin and Structure of the Universe) and the Maier-Leibnitz-Laboratorium (Garching).

TT 30.5 Thu 18:00 H20

Cryogenic light detectors with Neganov-Luke amplification — •Christian Isaila[1], Oliver Boslau[2], Christian Ciemniak[1], Chiara Coppi[1], Franz von Feilitzsch[1], Achim Gütlein[1], Josef Kemmer[2], Jean-Côme Lanfranchi[1], Andreas Pahlke[2], Sebastian Pfister[1], Walter Potzel[1], Wolfgang Rau[1], Sabine Roth[1], Michael Stark[1], Wolfgang Westphal[1], and Florian Wiest[2] — [1]Technische Universität München, Physik Department E15, James-Franck Str., 85748 Garching — [2]Ketek GmbH, Hofer Strasse 3, 81737 München

For an active suppression of the background due to electron recoils in the CRESST experiment both phonons and scintillation light generated in a $CaWO_4$ crystal are detected simultaneously using cryogenic detectors based on transition edge sensors (TES). As only a small fraction (about 1%) of the energy deposited in the crystal is detected as light, very sensitive light detectors are needed. Following Neganov and Luke, the threshold of the light detector can be improved by drifting the electron-hole pairs generated by the scintillation photons in an electric field. Thus additional phonons are created leading to an amplification of the signal. For an efficient charge collection Si substrates with low trap densities are required. For this purpose and for electrical decoupling, the TES is glued onto the Si substrate. Results from measurements with Neganov-Luke amplification using glued TES will be presented. This work has been supported by funds of the DFG (SFB 375, Transregio 27), the Cluster of Excellence (Origin and Structure of the Universe) and the Maier-Leibnitz-Laboratorium (Garching).

TT 30.6 Thu 18:15 H20

Investigation of the properties of tungsten thin films produced with the rf-sputtering technique — •Sabine Roth[1], Christian Ciemniak[1], Chiara Coppi[1], Franz von Feilitzsch[1], Achim Gütlein[1], Christian Isaila[1], Jean-Côme Lanfranchi[1], Sebastian Pfister[1], Walter Potzel[1], Wolfgang Westphal[1], Dieter Hauff[2], Emilja Pantic[2], Federica Petricca[2], Franz Pröbst[2], and Wolfgang Seidel[2] — [1]Physik-Department E15, Technische Universität München, James-Franck-Straße, D-85748 Garching — [2]Max-Planck-Institut für Physik, Föhringer Ring 6, D-80805 München

The detection principle of the CRESST experiment (Cryogenic Rare

Event Search with Superconducting Thermometers) is based on the 'phonon-light technique', suppressing the background due to electron recoils by the simultaneous measurement of the phonons and the scintillation light generated in a $CaWO_4$ crystal. For both channels cryogenic particle detectors based on Transition Edge Sensors (TESs) are employed. To ensure high sensitivity of the experiment, low working temperatures of the detectors are required. For this reason TESs consisting of tungsten thin films, with transition temperatures of about 10 mK, acting as the thermometers, are used. The manufacturing process of tungsten thin films with an rf-sputtering cathode in a vacuum facility will be discussed and characteristical properties of these films will be presented. This work has been supported by funds of the DFG (SFB 375, Transregio 27), the Cluster of Excellence (Origin and Structure of the Universe) and the Maier-Leibnitz-Laboratorium (Garching).

TT 30.7 Thu 18:30 H20

First experiments for precise Lamb shift measurements on hydrogen-like heavy ions with low temperature calorimeters — V. Andrianov[1,2], K. Beckert[1], P. Beller[1], •A. Bleile[1,2], P. Egelhof[1,2], A. Gumberidse[1], S. Illieva[1,2], C. Kilbourne[3], H.-J. Kluge[1], S. Kraft-Bermuth[1,2], D. McCammon[4], J.P. Meier[1,2], U. Popp[1], R. Reuschl[1], T. Stöhlker[1], and S. Trotsenko[1] — [1]Gesellschaft für Schwerionenforschung, Darmstadt, Germany — [2]Universität Mainz, Germany — [3]Goddard Space Flight Center, Greenbelt, USA — [4]Univ. of Wisconsin, Madison, USA

The precise determination of the Lamb shift in hydrogen-like heavy ions provides a sensitive test of quantum electrodynamics in very strong Coulomb fields, not accessible otherwise. To increase the accuracy of the Lamb shift measurement on stored heavy ions at the ESR storage ring at GSI, a calorimetric low temperature detector for hard X-rays was developed. The experimental requirements for the detector are the high absorption efficiency and a relative energy resolution of about 10^{-3} for 50-100 keV X-rays. A prototype array consisting of 8 pixels with silicon thermistors and Sn or Pb absorbers was recently applied in first experiments with stored $^{238}U^{91+}$ and $^{208}Pb^{81+}$ ions interacting with an internal gas-jet target. A total detection efficiency of $1x10^{-7}$ for the Lyman-α lines was reached and an energy resolution of 150 eV was obtained under the present experimental conditions. The results on the absolute energy determination of the Lyman-α lines will be discussed and the design of a new 32-pixel detector for future experiments will be presented.

TT 30.8 Thu 18:45 H20

Einkopplung von FIR-Laserstrahlung in ein Rastermikroskop mit $YBa_2Cu_3O_7$ Josephson-Cantilever — •Christian Brendel, Felix Stewing und Meinhard Schilling — Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik, TU Braunschweig, Hans-Sommer-Strasse 66, 38106 Braunschweig

Wir erzeugen mit einem optisch gepumpten Ferninfrarotlaser THz-Signale und koppeln diese in THz-Antennen zur Weiterverarbeitung ein. In unserem Rastermikroskop setzen wir Josephson-Cantilever aus $YBa_2Cu_3O_7$ auf Bikristallsubstraten ein, um gleichzeitig die Leistungsverteilung auf einer Leitung und deren Topologie zu messen. Der Josephson-Kontakt dient dabei als Mischer und Detektor, um die Signale mit Frequenzen bis in den Terahertz-Bereich mit höchster Empfindlichkeit zu detektieren. Diese Messmethode erlaubt den quantitativen Nachweis elektromagnetischer Strahlung im Nahfeld mit Mikrometerauflösung an Proben bei Raumtemperatur, obwohl die Josephson-Cantilever selbst mit einem Kleinkühler auf 30 K gekühlt werden.

TT 31: Low-dimensional Systems - Models I

Time: Thursday 17:45–19:15 Location: H19

TT 31.1 Thu 17:45 H19

Spectral broadening due to long-range Coulomb interactions in the molecular metal TTF-TCNQ — •Erik Koch[1], Andreas Dolfen[1], Laura Cano-Cortés[2], Jaime Merino[2], Jörg Behler[3], Karsten Reuter[3], and Bernard Delley[4] — [1]Institut für Festkörperforschung, Forschungszentrum Jülich — [2]Universidad Autónona de Madrid — [3]Fritz-Haber-Institut, Berlin — [4]Paul-Scherrer-Institut, Villigen

We employ density-functional theory to calculate realistic parameters for an extended Hubbard model of the molecular metal TTF-TCNQ. Considering both intra- and intermolecular screening in the crystal, we find that longer-range Coulomb interactions along the molecular stacks, as well as inter-stack coupling are of importance. Contrary to past belief, these terms do not lead to the formation of a Wigner lattice, but simply broaden the spectral function. We show how this can be understood already in perturbation theory. Moreover we calculate the effect of the nearest neighbor repulsion on the Luttinger parameter.

TT 31.2 Thu 18:00 H19

Indirect forces between impurities in one-dimensional quantum liquids — •Peter Wächter, Volker Meden, and Kurt Schönhammer — Institut für Theoretische Physik, Universität Göttingen, Göttingen, Germany

We investigate the indirect interaction between two isolated impurities in a Luttinger liquid modeled by a microscopic lattice model. To treat the electron-electron interaction U the functional renormalization group method is used. For comparison we also study the $U = 0$ case. For all U and generic values of the strength of the impurities we find that the impurity interaction as a function of their separation r oscillates between being attractive and repulsive. For $U = 0$ the amplitude of the interaction energy decays as $1/r$. For $U > 0$ the decay for small separations is governed by a U dependent exponent larger than -1, which crosses over to -1 for large r. The crossover scale depends on the impurity strength and U. We briefly comment on the case of attractive interaction $U < 0$ and the relation between the sign changes of the impurity interaction and transport resonances. In the special case of half-filling and for $U \geq 0$ we find that by fine tuning the impurity parameters one can create a situation in which the impurity interaction becomes purely attractive.

TT 31.3 Thu 18:15 H19

Temperature dependence of Coulomb drag between finite-length quantum wires — •Joël Peguiron, Björn Trauzettel, and Christoph Bruder — Department of Physics and Astronomy, University of Basel,Klingelbergstrasse 82, 4056 Basel, Switzerland

We evaluate the Coulomb drag current in two finite-length Tomonaga-Luttinger wires coupled by an electrostatic backscattering interaction. The drag current in one wire shows oscillations as a function of the drive voltage applied to the other wire, reflecting interferences of the plasmon standing waves in the interacting wires. In agreement with this picture, the amplitude of the current oscillations is reduced with increasing temperature. This is a clear signature of non-Fermi liquid physics because for coupled Fermi liquids the drag resistance is always expected to increase as the temperature is raised.

TT 31.4 Thu 18:30 H19

Correlated electrons with spin-orbit coupling in quantum dots and quantum wires — •Jens Eiko Birkholz and Volker Meden — Institut für Theoretische Physik, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

We use the functional renormalization group to investigate correlated electrons with spin-orbit coupling, represented by Rashba and Dresselhaus terms, in quantum dots and quantum wires. The interacting system is connected to semi-infinite leads which are considered to be interaction-free. Such setups are of interest as spin-filters in spintronics applications. As a measure for the electron transport through the dot and wire, we focus on the spin-dependent linear-response conductance. The interplay of electronic correlations and spin-orbit coupling leads to interesting physics.

TT 31.5 Thu 18:45 H19

Probing anomalous longitudinal fluctuations of the interacting Bose gas via Bose-Einstein condensation of magnons — •Andreas Kreisel, Nils Hasselmann, and Peter Kopietz — Institut für Theoretische Physik, Universität Frankfurt, Max-von-Laue Strasse 1, 60438 Frankfurt, Germany

The emergence of a finite staggered magnetization in quantum Heisenberg antiferromagnets subject to a uniform magnetic field can be

viewed as Bose-Einstein condensation of magnons. Using non-perturbative results for the infrared behavior of the interacting Bose gas[1], we present exact results for the staggered spin-spin correlation functions of quantum antiferromagnets in a magnetic field at zero temperature. In particular, we show that in dimensions $1 < D \leq 3$ the longitudinal dynamic structure factor $S_{\parallel}(\vec{q}, \omega)$ describing staggered spin fluctuations in the direction of the staggered magnetization exhibits a critical continuum, whose weight can be controlled experimentally by varying the magnetic field [2].

[1] F. Pistolesi, C. Castellani, C. Di Castro, and G. C. Strinati, Phys. Rev. B **69**, 024513 (2004)

[2] Andreas Kreisel, Nils Hasselmann and P. Kopietz, cond-mat/0610575

TT 31.6 Thu 19:00 H19

Cluster approach to magnetic excitations in high-T_c superconductors — •Sascha Brehm[1], Enrico Arrigoni[2], Michael Potthoff[1], Markus Aichhorn[1], and Werner Hanke[1] — [1]Institut für Theoretische Physik und Astrophysik, Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany — [2]Institut für Theoretische Physik, Technische Universität Graz, Petersgasse 16, A-8010 Graz, Austria

A new scheme is presented for calculating two-particle spin and charge response functions within symmetry-broken, e.g. antiferromagnetic (AF) and d-wave superconducting (dSC), phases. The scheme is based on the variational cluster approach (VCA). Normal and anomalous one-particle Green's functions of the two-dimensional Hubbard model in the thermodynamical limit are obtained from variationally optimized self-energies of finite clusters with up to 10 sites. At zero temperature, a band Lanczos algorithm is used for the cluster diagonalization. Analogous to the one-particle level, the magnetic and charge susceptibilities are then derived from the frequency-dependent two-particle vertex of the isolated cluster. Results are presented for the AF half-filled case, for the underdoped system with microscopically coexisting AF and dSC order as well as for the paramagnetic dSC phase at optimal doping. Characteristic features of the filling-dependent magnetic excitation spectrum (collective modes as well as continuum) are worked out for normal state and AF/dSC symmetry-broken phases.

TT 32: Fluctuations and Noise

Time: Thursday 18:00–19:15 Location: H18

TT 32.1 Thu 18:00 H18

Full Counting Statistics of an Aharonov-Bohm Interferometer with an embedded Quantum Dot — •Daniel Urban[1,2], Rosario Fazio[2,3], and Jürgen König[1] — [1]Ruhr-Universität Bochum — [2]Scuola Normale Superiore, Pisa — [3]International School for Advanced Studies, Trieste

The visibility of the interference signal in Aharonov-Bohm (AB) interferometers provides information about the coherence of transport channels. For instance, spin-flip processes in embedded quantum dots lead to partial destruction of the coherence [1] and thus reduction of the AB-oscillation amplitude. The occurrence of this effect depends on the dot occupation.

We perform a perturbation expansion of the Cumulant Generating Function [2] of an AB-Interferometer with quantum dots in the regime of weak tunnel coupling. Different statistics are found for vanishing and infinite charging energy: Without interaction the interfering part of the statistics is Poisson-like and all moments are even in the AB-flux. For an interacting quantum dot we find completely different behavior with super-poissonian noise and an odd flux dependence.

[1] J. König and Y. Gefen, PRL **86**, 3855 (2001).

[2] A. Braggio, J. König, and R. Fazio, PRL **96**, 026805 (2006).

TT 32.2 Thu 18:15 H18

Noise and Full Counting Statistics in Coupled Quantum Dots — Ramon Aguado[2], •Tobias Brandes[1], Clive Emary[1], Gerold Kiesslich[1], David Marcos[2], Eckehard Schöll[1], and Philipp Zedler[1] — [1]Institut für Theor. Physik, TU Berlin — [2]Departamento de Teoria de la Materia Condensada, CSIC, Madrid

We discuss shot noise and higher current cumulants in quantum dots [1] with internal couplings (such as double quantum dots) by calculating the Full Counting Statistics within a master equation approach in the limit of strong bias and strong Coulomb blockade. We present results for models that include a coupling to internal relaxation processes (dissipation due to phonons) and exhibit interesting limiting cases such as quantum Zeno localization due to strong coupling to the drain reservoir [2].

[1] G. Kießlich, P. Samuelsson, A. Wacker, and E. Schöll, Phys. Rev. B 73, 033312 (2006). [2] T. Brandes, Phys. Stat. Sol. B 243, 2293 (2006).

TT 32.3 Thu 18:30 H18

Frequency-dependent full counting statistics — Clive Emary[1], •David Marcos[2], Ramon Aguado[2], and Tobias Brandes[1] — [1]TU Berlin, Sekr. PN 7-1, Institut für Theoretische Physik, Hardenbergstr. 36, D-10623 Berlin, Deutschland — [2]Departamento de Teoría de la Materia Condensada, Instituto de Ciencia de Materiales de Madrid, Consejo Superior de Investigaciones Científicas (CSIC), C/ Sor Juana Inés de la Cruz, 3, Campus de Cantoblanco, Madrid 28049, Spain

Full Counting Statistics (FCS) is fast becoming one of the most powerful theoretical tools for studying electronic transport through mesoscopic devices. The extra information FCS provides over and above average current and shot-noise measurements, yields greater insight into the behaviour of the system, and in particular particle correlations. Most calculations to date have considered FCS in the zero-frequency, or single-time limit. Here, we describe our technique for calculating arbitrary-order multiple-time current correlators, and hence a fully frequency-dependent FCS. Our formalism is derived within the generalised density matrix approach and is therefore of wide applicability.

TT 32.4 Thu 18:45 H18

Full counting statistics of photon-assisted transport in a quantum point contact — •Mihajlo Vanevic[1], Yuli V. Nazarov[2], and Wolfgang Belzig[3] — [1]Departement für Physik und Astronomie, Klingelbergstrasse 82, 4056 Basel, Switzerland — [2]Kavli Institute of NanoScience, Delft University of Technology, 2628 CJ Delft, The Netherlands — [3]Fachbereich Physik, Universität Konstanz, D-78457 Konstanz, Germany

We study the charge transport statistics in a coherent quantum point contact driven by a time-dependent voltage. We obtain that the cumulant generating function at zero temperature consists of a dc component which describes the unidirectional charge transfer and the ac component which accounts for the photon-assisted effects in the noise and higher-order even cumulants. We provide a simple interpretation in terms of electron-hole excitations and discuss the relation to the minimal excitation states for optimal Lorentzian voltage pulses. The extended Keldysh-Green's function technique which we use is suitable for the systematic calculation of the higher-order current correlators at finite temperatures in the presence of the driving.

TT 32.5 Thu 19:00 H18

Bound states in time-dependent quantum transport — •Elham Khosravi[1], Stefan Kurth[1], Gianluca stefanucci[1], Angel Rubio[2], and Eberhard Gross[1] — [1]Institut fuer Theoretische Physik, Freie Universitaet Berlin,Berlin, Germany — [2]Donostia International Physics Center(DIPC),San Sebastian,Spain

We present a description of transport based on the time evolution of the non-interacting time-dependent Schroedinger equation and develop a numerical algorithm for the time propagation of open systems which is ideally suited for implementation of time-dependent density functional theory. The algorithm is used to study time-dependent transport phenomena. In particular, we investigate the role of bound states and transients in simple model systems. The presence of two or more bound states in the biased electrode-device-electrode system leads to current oscillations that remain undamped even in the long-time limit. Such oscillations might open new conductive channels, an effect which is not accounted for in any steady-state approach.

TT 33: Low-dimensional Systems - Models II

Time: Friday 10:15–13:00 Location: H18

TT 33.1 Fri 10:15 H18

String order: a common (and fragile) characterization of 1D insulators — •Fabrizio Anfuso and Achim Rosch — Institute of Theoretical Physics, University of Cologne

The ground-state of spin-1 Haldane chains is characterized by the so-called string order. We show that the same hidden order is also present in ordinary one-dimensional band insulators. We construct a family of Hamiltonians which connects adiabatically band insulators to two topologically non-equivalent spin models, the Haldane chain and the antiferromagnetic spin-1/2 ladder. We observe that localized spin-1/2 edge-state characteristic of spin-1 chains is smoothly connected to a surface-bound state of band insulators and its emergence is not related to any bulk phase transition. Furthermore, we show that the string order is absent in any dimensions higher than one and we discuss the similar fate of other non-local hidden orders.

TT 33.2 Fri 10:30 H18

Chain breaks and the susceptibility of $Sr_2Cu_{1-x}Pd_xO_{3+\delta}$ and other doped quasi one-dimensional antiferromagnets — •Jesko Sirker[1], Nicolas Laflorencie[1], Satoshi Fujimoto[2], Sebastian Eggert[3], and Ian Affleck[1] — [1]Department of Physics and Astronomy, University of British Columbia, Vancouver, British Columbia, Canada V6T 1Z1 — [2]Department of Physics, Kyoto University, Kyoto 606-8502, Japan — [3]Department of Physics, University of Kaiserslautern, 67663 Kaiserlautern, Germany

We study the magnetic susceptibility of one-dimensional S=1/2 antiferromagnets containing non-magnetic impurities which cut the chain into finite segments. For the susceptibility of long anisotropic Heisenberg chain-segments with open boundaries we derive a parameter-free result at low temperatures using field theory methods and the Bethe Ansatz. The analytical result is verified by comparing with Quantum-Monte-Carlo calculations. We then show that the partitioning of the chain into finite segments can explain the Curie-like contribution observed in recent experiments on $Sr_2Cu_{1-x}Pd_xO_{3+\delta}$. Possible additional paramagnetic impurities seem to play only a minor role.

TT 33.3 Fri 10:45 H18

Groundstates and thermodynamics of a highly frustrated spin model — •Andreas Honecker[1], Daniel Cabra[2], Hans-Ulrich Everts[3], Pierre Pujol[4], and Franck Stauffer[5] — [1]Institut für Theoretische Physik, Georg-August-Universität Göttingen, Germany — [2]ULP Strasbourg, Lab. Physique Théorique, France — [3]Institut für Theoretische Physik, Leibniz Universität Hannover, Germany — [4]Lab. Physique Théorique, Université Paul Sabatier Toulouse, France — [5]Institut für Theoretische Physik, Universität zu Köln, Germany

We consider a strongly trimerized kagomé lattice, as might be realized e.g. by fermionic atoms in optical lattices. For 2/3 filling, the chirality degrees of freedom of the individual triangles are governed by a pseudo-spin-1/2 Hamiltonian on a triangular lattice. According to previous studies, relevant aspects are captured by the classical version of this Hamiltonian. The properties of the model differ significantly for the different signs of the exchange constant. In one case, the ground-state is a 120° spin structure. Because of the discrete symmetry of the Hamiltonian we expect a finite-temperature ordering transition. In Monte Carlo (MC) simulations we measure specific heat, order parameter and the associated Binder cumulant. We determine the transition temperature and critical exponents. In the other case, which corresponds more closely to the kagomé antiferromagnet, the groundstates are macroscopically degenerate. A thermal order-by-disorder mechanism selects another 120° structure for the pseudo-spins, however only at very low temperatures. This phase transition is detected with MC simulations using the exchange method.

TT 33.4 Fri 11:00 H18

Classical Transport on Lattices with Frustrated Interactions — •David Leipold and Erich Runge — TU Ilmenau, Institut für Physik, D-98693 Ilmenau

Fractionally charged quasi-particles are subject of several recent theoretical investigations studying quantum particles on lattices with frustrated interactions. Examples are the three-dimensional pyrochlore lattice and its two-dimensional counterpart, the criss-crossed checkerboard lattice [1,2]. The corresponding classical systems have highly degenerated ground states for particular occupation densities [3]. Little is known about their transport properties. We analyze electric transport for the checkerboard lattice by classical thermodynamic Monte-Carlo simulations at finite temperature, varying the external electrical field and the particle densities. We argue that the classical electric transport behavior is best interpreted in terms of fractional charged entities or quasi-particles. We confirm our numercial simulation results in various limits by analytical calculations.

[1] E. Runge and P. Fulde, Phys. Rev. B **70**, 245113 (2004)
[2] F. Pollmann, P. Fulde, E. Runge, Phys. Rev. B **73**, 125121 (2006)
[3] F. Pollmann, J. J. Betouras, E. Runge, Phys. Rev. B **73**, 174417 (2006)

TT 33.5 Fri 11:15 H18

Thermodynamik des zweidimensionalen J_1-J_2-Modells in hohen Magnetfeldern — •Burkhard Schmidt[1], Nicolas Shannon[2] und Peter Thalmeier[1] — [1]Max-Planck-Institut für Chemische Physik fester Stoffe, 01187 Dresden — [2]H H Wills Physics Laboratory, Tyndall Avenue, Bristol BS8 1TL,

Das frustrierte zweidimensionale J_1-J_2-Heisenbergmodell auf dem Quadratgitter beschreibt den Magnetismus in einer Klasse von Vanadiumoxid-Schichtstrukturen vom Typ AA'VO$(PO_4)_2$ (A, A' = Pb, Zn, Sr, Ba). Dabei sind die Austauschkonstanten wenige Kelvin groß. Wir berichten hier über Resultate zum Verhalten des J_1-J_2-Modells in hohen Magnetfeldern. Aufgrund der kleinen Austauschkonstanten sind die Sättigungsfelder experimentell erreichbar und im Bereich von 20 Tesla. Wir zeigen, dass aufgrund der Frustration am Sättigungsfeld ausgeprägte thermodynamische Anomalien zu erwarten sind, diese können umgekehrt zur Bestimmung des Frustrationswinkels benutzt werden. Wir verwenden die Methode der exakten Diagonalisierung bei endlichen Temperaturen für Cluster bis N=24 und vergleichen mit analytischen Spinwellen Rechnungen. Insbesondere werden die spezifische Wärme im Magnetfeld und der magnetokalorische Effekt sowie die Bedingungen für sein anomales Verhalten ausführlich untersucht. Es wird gezeigt, dass eine Verstärkung dieses Effekts um eine Grössenordnung gegenüber der paramgnetischen Referenz zu erwarten ist. Die Gründe dafür liegen in der anomalen Dispersion der Spinwellen, die durch Frustrationseffekte verursacht wird.

TT 33.6 Fri 11:30 H18

Entanglement entropy in fermionic Laughlin states — •Masud Haque — MPI-PKS, Dresden, Germany

We present analytic and numerical calculations on the bipartite entanglement entropy in fractional quantum Hall states of the fermionic Laughlin sequence. The partitioning of the system is done both by dividing Landau level orbitals and by grouping the fermions themselves. For the case of orbital partitioning, our results can be related to spatial partitioning, enabling us to extract a topological quantity (the 'total quantum dimension' and the 'topological entropy') characterizing the Laughlin states.

15 min. break

TT 33.7 Fri 12:00 H18

Fractional charges and spin-charge separation in one-dimensional Wigner lattices — Maria Daghofer and •Peter Horsch — MPI for Solid State Research, Stuttgart, Germany

We study density response $N(k,\omega)$ and one-particle spectra $A(k,\omega)$ for a Wigner lattice model at quarter filling using exact diagonalization. These spectra show clear signatures of charge fractionalization into pairs of domain walls, whose interaction can be attractive or repulsive and is controlled by the formal fractional charges. In striking contrast to a bound exciton in $N(k,\omega)$, we find an antibound quasi-particle in $A(k,\omega)$, which undergoes spin-charge separation. We present a case of extreme particle-hole asymmetry, where photoemission shows spin-charge separation, while inverse photoemission exhibits uncorrelated one-particle bands.

Inclusion of the spin degree of freedom reduces the stability region of the Wigner crystal in the phase diagram. For some parameters, the system becomes ferromagnetic.

TT 33.8 Fri 12:15 H18

Nonmagnetic impurities in fractionalized spin liquids — •Alexei Kolezhuk[1] and Subir Sachdev[2] — [1]Institut für Theoretische Physik, Universität Hannover, 30167 Hannover, Germany — [2]Physics Department, Harvard University, Cambridge MA 02138, USA

Spin correlations in the vicinity of a nonmagnetic impurity are analyzed for two models of gapless U(1) spin liquids in two dimensions: (1) deconfined critical point between the Neel and valence-bond-solid (VBS) phase; (2) staggered flux spin liquid. The impurity susceptibility in both cases exhibits a 1/T temperature dependence with an anomalous Curie constant. It is shown that an external magnetic field induces both uniform and staggered magnetization around the impurity in the Neel-VBS case, while in the staggered flux phase only the uniform component is present.

TT 33.9 Fri 12:30 H18

Confinement of spinons in the spiral staircase model — •Christian Brünger and Fakher Assaad — Universität Würzburg, Germany

We consider two antiferromagnetic spin 1/2 chains with coupling constants J and $J\cos^2(\theta/2)$ coupled ferromagnetically, $J_\perp$. In the limit $J_\perp \to \infty$ the model maps onto the Haldane spin 1 chain irrespective of te choice of the angle θ. The question we address here is the confinement of spinons in the weak coupling region. As expected from bosonization [1] at $\theta = 0$ the spin gap varies linearly with $J_\perp$. On the other hand in the limit $\theta = \pi$ our results suggest that this spin gap opens as $(J_\perp)^\alpha$ with $\alpha \simeq 2$. This statement follows from mean-field, exact diagonalization as well as large scale quantum Monte Carlo simulations.

[1] D. G. Shelton, A. A. Nersesyan and A.M. Tsvelik, Phys. Rev. B **53**, 8521 (1996)

TT 33.10 Fri 12:45 H18

Experimental Consequences of O(3) Deconfined Criticality in 2+1 D — •David Santiago[1] and Zaira Nazario[2] — [1]Insituut-Lorentz, Leiden University, P.O. Box 9506, NL-2300 RA Leiden, The Netherlands — [2]Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Str. 38, 01187 Dresden, Germany

The paramagnetic phase of 2+1 D antiferromagnets can be described in terms of electrodynamics of charged, massive bosonic spinons interacting through an emergent compact U(1) gauge field. Spinons in the paramagnet are confined due to the presence of nontrivial tunneling effects, instantons which provide a long range interaction between the gauge fields and the charges that gaps the gauge fields and provides a linear potential for the charges. The instantons responsible for spinon confinement in the paramagnetic phase vanish at the quantum critical point. Therefore, spinons are deconfined at criticality. We have recently obtained the effective theory that describes the universal physics of these deconfined critical points. From the deconfined critical theory, we calculate the critical Neel field propagator and find a critical exponent eta=1. We also obtain measurable effects and quantities that follow from the prediction eta=1 and serve as characterization of O(3) deconfined criticality. Those are the inelastic and elastic neutron scattering response, Nuclear Magnetic Resonance (NMR) response, magnetic field response and the specific heat. All of these response functions serve to define the O(3) deconfined universality class.

TT 34: Superconductivity - Vortex Dynamics, Vortex Phases, Pinning

Time: Friday 10:15–13:00 Location: H19

TT 34.1 Fri 10:15 H19

Commensurability effects in Nb thin films with (quasi-)periodic pinning arrays — •Matthias Kemmler[1], Daniel Bothner[1], Albert Sterck[1], Michael Siegel[2], Reinhold Kleiner[1], and Dieter Koelle[1] — [1]Physikalisches Institut - Experimentalphysik II,Universität Tübingen, Auf der Morgenstelle 14, D-72076Tübingen — [2]IMS, Universität Karlsruhe,Hertzstr. 16, D-76187 Karlsruhe

We study experimentally the critical depinning current I_c versus applied magnetic field B in Nb thin films which contain 2D arrays of circular antidots placed on the nodes of a fivefold Penrose lattice.

For measurements of electric transport we use a highly sensitive liquid Helium-cooled dc SQUID amplifier. The sample temperature is controlled and stabilized close to the Nb transition temperature T_c via an optical, very low noise heating system.

Our experiments confirm essential features in the $I_c(B)$ patterns as predicted by Misko *et al.*[1] , close to the transition temperature T_c of the Nb films.

In order to find the arrangement of optimal pinning we compare the performance of Nb films containing quasiperiodic pinning arrays, triangular pinning arrays, randomly distributed antidots, or no antidots. Some of the results are published in [2].

[1] V.R. Misko, S.Savel'ev, F.Nori, Phys. Rev. Lett. 95 (2005) 177007

[2] M. Kemmler et al., Phys. Rev. Lett. 97 (2006) 147003

TT 34.2 Fri 10:30 H19

Vortex Structures in Tantalum, Vandium and Niobium — •Sebastian Mühlbauer[1], Peter Böni[1], Christian Pfleiderer[1], Robert Georgii[2], Edward Forgan[3], Charlotte Bowell[3], and Mark Laver[3] — [1]Physikdepartment E21, TU München, Garching — [2]Foschunsgneutronenquelle Heinz Maier-Leibnitz, Garching — [3]School of Physics and Astronomy, Birmingham (UK)

Small angle neutron scattering directly maps the fourier transform of the vortex lattice (VL) of type II superconductors and gives valuable informations on both the underlying fermi surface and the mechanism of the superconducting pairing. But the symmetry of the VL is also mainly influenced by pinning and impurity effects. Recent studies of the VL in the classical superconductors Tantalum, Vanadium and Niobium with field applied along the four-fold (100) axis will be presented. Four fold VL patterns, breaking the crystal symmetry have been identified in Niobium, which can be explained by non-local corrections in the Eilenberger model. Furthermore, recent polarised neutron studies of the VL in Niobium will be presented.

TT 34.3 Fri 10:45 H19

Effect of dc magnetic field on the microwave losses in MgB_2 thin films — •Alexander Zaitsev, Rudolf Schneider, Roland Hott, Thorsten Schwarz, and Jochen Geerk — Forschungszentrum Karlsruhe, Institut für Festkörperphysik, P.O.B. 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 GHz 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 the 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 34.4 Fri 11:00 H19

Superconducting Transition Broadening in MgB_2 — •Anatolie Sidorenko[1], Vladimir Zdravkov[1], Andrej Sudru[1], Dimitriu Ghitsu[1], Thomas Koch[2], and Thomas Schimmel[2,3] — [1]Institute of Electronic Engineering and Industrial Technologies, ASM, MD-2028 Kishinev, Moldova — [2]nstitute of Nanotechnology, Forschungszentrum Karlsruhe D-76021 Karlsruhe, Germany — [3]Institute of Applied Physics, University of Karlsruhe D-76128 Karlsruhe, Germany

Superconducting properties of high-quality films of the first multiband superconductor, magnesium diboride, have been investigated. Two mechanisms with intrinsic origin of the superconducting transition broadening for MgB_2 were found. The dominating role of two-dimensional fluctuations in the vicinity of the critical temperature and

thermally activated flux flow for the low parts of the superconducting transition are responsible for the resistivity of MgB_2 near the superconducting transition. The reasons for the observed extraordinary strong dependence of the activation energy of flux motion on the external magnetic field are discussed

TT 34.5 Fri 11:15 H19

Pinning and disorder effects of SiC and C additions in MgB_2 by magnetic relaxation and specific heat analysis — •C Senatore[1], R Lortz[1], SX Dou[2], and R Flükiger[1] — [1]DPMC and MaNEP, Universite de Geneve, Switzerland — [2]Institute for Superconductivity and Electronic Materials, University of Wollongong, Australia

The relatively high T_c and the reduced fabrication costs of MgB_2 render this material promising for industrial applications, especially in substitution to Nb_3Sn in the magnetic field range 9-12 T or in view of cryogen free devices, operating at 20 K. The addition of nanometric powders of SiC and C enhances both B_{irr} and J_c. However, the underlying physical mechanism is not completely understood. We have analyzed the effects of SiC and C doping on the superconducting properties of MgB_2 bulks by means of specific heat and magnetic relaxation measurements. Pinning in MgB_2 is governed by grain boundaries. To discriminate the influence of the additions on the pinning properties from the grain size effects, magnetic relaxation measurements have been performed on doped samples sintered at different temperatures. A series of binary MgB_2 has been used as reference. Doping introduces disorder into the superconductor and thus raises B_{c2}. In the case of $MgB_{1.9}C_{0.1}$, specific heat measurements show that the C substitution on the B sites modifies the low temperature shoulder related to the second gap. This effect is not visible in the samples doped with SiC. SiC leads to an inhomogeneous distribution of C as seen from the distribution of T_c determined from the calorimetric data.

TT 34.6 Fri 11:30 H19

MgB_2 - a self organised critical system — •Andreas Heinrich[1], Emmeram Stark[1], Monika Panhans[1], Bernd Stritzker[1], and Rudolf Schneider[2] — [1]Universität Augsburg, EPIV, 86135 Augsburg — [2]Forschungszentrum Karlsruhe, IFP, Karlsruhe

Systems like a sand hill or water droplets are treated in terms of a self organised critical system. Thereby several conditions apply for such a system: it should consist of many components, it should organise itself into a critical state, there should be an exceptional event - like an avalanche, this events should be invariant in time and scale, etc. Here we would like to present magneto optical investigations of flux penetration into MgB_2 thin films. Thereby one can differ between a homogeneous and an avalanche like flux penetration. We will show that especially the avalanche like flux penetration can be treated like a self organised critical system. In comparison with a sand hill we will demonstrate the avalanche or dendrite flux formation in MgB_2 exhibit all requirements mentioned above.

15 min. break

TT 34.7 Fri 12:00 H19

Vortex lattice in superconducting films of finite thickness — •Ernst Helmut Brandt — Max-Planck-Institut für Metallforschung, Stuttgart

Magnetic stray field, currents, self-energy, and interaction of vortices in superconductor films of any thickness are of interest for numerous applications. In the London limit of negligibly small vortex core, the general analytical solution for arbitrary arrangements of straight and curved vortex lines is given in [1]. For finite vortex core size, the corresponding solution of Ginzburg-Landau theory is needed, which requires huge numerical effort. However, if the vortex lattice is ideally periodic in the film plane, the problem simplifies and an extension of a previous bulk method is possible, which includes the stray field energy outside the film. This calculation was performed for vortices oriented perpendicular to the film [2]. A similar computation is possible also for a periodic arrangement of arbitrarily tilted or curved vortex lines in a thick film.

[1] G. Carneiro and E. H. Brandt, Phys. Rev. B **61**, 6370 (2000).
[2] E. H. Brandt, Phys. Rev. B **71**, 014521, 1-12 (2005).

TT 34.8 Fri 12:15 H19

Vortex induced deformation of the superconductor crystal lattice — Pavel Lipavsky[1], •Klaus Morawetz[2,3], Jan Kolacek[4], and Ernst Helmut Brandt[5] — [1]Faculty of Mathematics and Physics, Charles University, Ke Karlovu 3, 12116 Prague 2, Czech Republic — [2]Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany — [3]Max Planck Institute for the Physics of Complex Systems, Noethnitzer Str. 38, 01187 Dresden, Germany — [4]Institute of Physics, Academy of Sciences, Cukrovarnická 10, 16253 Prague 6, Czech Republic — [5]Max Planck Institute for Metals Research, D-70506 Stuttgart, Germany

The deformation of the superconductor crystal lattice caused by Abrikosov vortices is expressed as response of the elastic crystal lattice to electrostatic forces. It is shown that the lattice compression is linearly proportional to the electrostatic potential known as the Bernoulli potential, which is related to the kinetic energy of the supercurrents. Possible consequences of the crystal lattice deformation on the effective vortex mass are discussed. [cond-mat/0609669]

TT 34.9 Fri 12:30 H19

Structurally induced anisotropic formation of vortex avalanches — •J. Albrecht[1], H.-U. Habermeier[2], A. Matveev[3], D.V. Shantsev[4], Y.M. Galperin[4], and T.H. Johansen[4] — [1]MPI für Metallforschung, Heisenbergstr. 3, D-70569 Stuttgart, Germany — [2]MPI für Festkörperforschung, Heisenbergstr. 1, D-70569 Stuttgart, Germany — [3]Chemistry Department, Lomonosov MSU, 119992 Moscow, Russia — [4]Department of Physics, University of Oslo, Blindern, 0316 Oslo, Norway

Anisotropic penetration of magnetic flux in MgB2 films grown on vicinal sapphire substrates is investigated using magneto-optical imaging. Regular penetration above 10 K proceeds more easily along the substrate surface steps, anisotropy of the critical current being 6 %. At lower temperatures the penetration occurs via abrupt dendritic avalanches that preferentially propagate perpendicular to the surface steps. This inverse anisotropy in the penetration pattern becomes dramatic very close to 10 K where all flux avalanches propagate in the strongest-pinning direction. The observed behavior is fully explained using a thermomagnetic model of the dendritic instability.

TT 34.10 Fri 12:45 H19

Critical currents in high-temperature superconductor/ferromagnet heterostructures — •Märit Djupmyr[1], Soltan Soltan[2,3], Hanns-Ulrich Habermeier[2], and Joachim Albrecht[1] — [1]Max-Planck-Institut für Metallforschung, Heisenbergstr. 3, D-70569 Stuttgart — [2]Max-Planck-Institut für Festkörperforschung, Heisenbergstr. 1, D-70569 Stuttgart — [3]Physics Department, Faculty of Science, Helwan University, 11795 Cairo, Egypt

The critical current in bilayer structures consisting of high-temperature superconducting $YBa_2Cu_3O_{7-\delta}$(YBCO) and ferromagnetic $La_{2/3}Ca_{1/3}MnO_3$ thin films, is substantially influenced by the presence of the ferromagnetic layer at low temperatures. Using quantitative magneto-optics a detailed analysis of the temperature dependence of the critical currents is done in the range T=10-90 K, giving information about the mechanisms of flux line pinning. For YBCO thin films, different current limiting mechanisms have been found depending on temperature and microstructure. For temperatures above T=40 K thermal depinning of flux lines is most important for the YBCO thin films as for the bilayers. Below T=40 K, the granularity of the film plays an important role for the current transport in the YBCO thin film and the ferromagnetic layer strongly affects the critical current in the bilayer.