TT 37: MLT: Poster Session

Time: Thursday 14:00–18:00 Location: Poster A

TT 37.1 Thu 14:00 Poster A

Superconductor-insulator transition in TiN films — •David Kalok[1], Ante Bilušić[1,2], Tatyana Baturina[3], Mikhaïl Baklanov[4], Valerii Vinokur[5], and Christoph Strunk[1] — [1]Institute for Experimental and Applied Physics, University of Regensburg, Germany — [2]Department on Physics, University of Split, Croatia — [3]Institute of Semiconductor Physics, Novosibirsk, Russia — [4]IMEC, Leuven, Belgium — [5]Materials Science Division, Argonne National Laboratory, USA

In the past years, several unusual features of the insulating state terminating superconductivity in strongly disordered superconducting films have been revealed. We investigate low-temperature transport properties of thin TiN films on the insulating side of the superconductor-insulator transition (SIT). At higher temperature, $T \geq 50\ mK$, we observe a thermally activated conductance with activation energy $E_A/k_b = 0.5\ K$. At lower temperatures, IV measurements show a threshold voltage V_T, below which the conductance is orders of magnitudes lower. Activation energy E_A and threshold V_T depend in a non-monotonic way on magnetic field and moreover on the orientation of the magnetic field. The influence of electron heating on the switching mechanism is investigated. We explore the B-Field driven SIT in parallel and perpendicular field.

TT 37.2 Thu 14:00 Poster A

Search for quantum phases in frustrated systems — •Ansgar Kalz, Andreas Honecker, Sebastian Fuchs, and Thomas Pruschke — Institut für Theoretische Physik, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

We use quantum Monte-Carlo simulations to analyse phase diagrams of spin models on two-dimensional lattice geometries with competing interactions. The frustration suppresses the classically ordered phases and we expect the emergence of phases which originate by quantum fluctuations like superfluidity or dimer ordering.

For the square lattice with nearest and next-nearest neighbour interaction the magnetically ordered states are the Néel state and the collinear state. The phase transitions for these classically ordered phases tend towards zero temperature for increasing quantum fluctuations. In a certain region of frustration and quantum fluctuations the classical phases vanish completely and new groundstates appear. We analyse the nature of these new groundstates by calculating correlations of multiple spin interactions.

We present the behaviour of the classical and quantum mechanical order parameters like staggered magnetisation, superfluid density and dimer-dimer correlations in temperature and parameter space. We show finite and zero temperature phase diagrams and look at the properties of the emerging phase transitions.

TT 37.3 Thu 14:00 Poster A

Anomalous diffusion of strongly correlated fermions in an optical lattice — •Stephan Mandt[1], David Rasch[1], Theo Costi[2], and Achim Rosch[1] — [1]Institute of Theoretical Physics, Cologne, Germany — [2]Forschungszentrum Jülich, Germany

We study the expansion of a cloud of strongly correlated fermionic atoms in an optical lattice. Initially, the cloud has a narrow Gaussian density profile but it spreads apart after being released from an additional confining potential. In experiment, it is observed that the particles at the edge of the cloud move ballistically. This ballistic motion is governed by the cubic symmetry of the lattice which is reflected in the characteristic shape of the expanding cloud. In contrast, the atoms at the center of the cloud are dominated by interparticle collisions and behave diffusively. Modelling the system in the framework of the Boltzmann equation, we describe the spatial crossover from ballistic to diffusive dynamics and recover the experimental observations made by the group of Immanuel Bloch.

TT 37.4 Thu 14:00 Poster A

Low temperature dielectric properties of $^{88}Sr^{48}TiO_3$ — •F. Aslan[1], T. Peichl[1], G. Fischer[1], S. Schöllhammer[2], W. Menesklou[2], and G. Weiss[1] — [1]Physikalisches Institut — [2]Institut für Werkstoffe der Elektrotechnik, KIT 76128 Karlsruhe

It is well established that the behavior of amorphous solids at low temperatures is governed by atomic two-level tunneling systems with properties as detailed in the phenomenological tunneling model. However, this genuine tunneling model fails to explain the recently measured magnetic field dependence of the low temperature dielectric properties of glasses. Extensions of the tunneling model that include a coupling of the lateral motion of the atoms to the orientation of their nuclear quadrupole moment could explain at least some of the observed magnetic field effects. In our studies, we try to directly demonstrate this idea by comparing the dielectric behavior of $SrTiO_3$-ceramics made of isotopes of natural abundance with that of samples enriched with the isotopes ^{88}Sr and ^{48}Ti which have no nuclear quadrupole moment. In contrast to the expectation, the magnetic field effects of the dielectric constant of $^{88}Sr^{48}TiO_3$ were not smaller but even 4.5 times larger than those of SrTiO3 with natural components. SQUID-magnetometer measurements revealed that our $^{88}Sr^{48}TiO_3$-material contains about 6 times more ferromagnetic and two orders of magnitude more paramagnetic impurities than our natural $SrTiO_3$. Although ruled out by other authors, this again rises the question whether the sensitivity to magnetic fields of the dielectric properties of glasses at low temperatures is caused by magnetic impurities.

TT 37.5 Thu 14:00 Poster A

Low temperature vibrating reed measurements of Zr based metallic glasses — •C. Adler, W. Mohr, T. Peichl, and G. Weiss — Physikalisches Institut, Karlsruher Institut für Technologie 76128 Karlsruhe

The low temperature thermal and acoustic behavior of glasses, dielectric or metallic, is dominated by two-level systems caused by the tunneling of small groups of atoms between two almost equivalent sites. Specific distributions of the relevant parameters are suggested by the well established tunneling model. Acoustic measurements of various superconducting metallic glasses demonstrate that conduction electrons not only drastically change the dynamics of tunneling systems as compared to insulating glasses but also seem to influence the apparent density of states of the tunneling systems. The advent of bulk metallic glasses (BMG) considerably facilitates acoustic experiments. Our vibrating reed measurements of the BMG $Zr_{59}Ti_3Cu_{20}Ni_8Al_{10}$ and the splat cooled metallic glass $Zr_{65}Al_{7.5}Cu_{27.5}$ reveal interesting differences in the internal friction which presumably reflect the quite different cooling rates in the preparation procedures of the two metallic glasses.

TT 37.6 Thu 14:00 Poster A

Investigation of mechanical losses in bulk materials for gravitational wave detectors — •Christoph Heilmann[1], Daniel Heinert[1], Christian Schwarz[1], Andreas Tünnermann[2], and Paul Seidel[1] — [1]Friedrich-Schiller-Universität Jena, Institut für Festkörperphysik, Helmholtzweg 5, 07743 Jena, Germany — [2]Friedrich-Schiller-Universität Jena, Institut für Angewandte Physik, Albert-Einstein-Straße 15, 07745 Jena, Germany

One of the dominating noise sources in gravitational wave detectors is thermal noise of the optical components. The Brownian motion of the bulk sample's surface is directly coupled to the mechanical loss of the substrate material.

We present measurements of the mechanical loss for different substrate materials in a temperature range from 5 K to 300 K. Thereby, we focus on monocrystalline samples of calcium fluoride, silicon and sapphire. Silicon – as a low loss material – is the most promising candidate material for the use in gravitational wave detectors. We demonstrate mechanical losses as low as 1.8×10^{-9} at a temperature of 5.6 K. We present a summary of possible damping mechanisms in the different materials and compare them to the experimental values obtained from our cryogenic loss spectroscopy.

This work is supported by the DFG under contract SFB TR7.

TT 37.7 Thu 14:00 Poster A

Dielectric spectroscopy on magnetically doped relaxor ferroelectrics — •Daniel Niermann and Joachim Hemberger — 2. Physikalisches Institut, Universität zu Köln

Materials showing a mutual dependence between magnetization and electric polarization in external fields got into the focus of recent research during the last years, not at least due to possible technical applications. It was recently shown that magnetoelectric behaviour can

not only be observed in materials exhibiting long-range ferromagnetic and ferroelectric orders, so called multiferroics, but also in disordered multiglasses with two different glassy states. We performed Fe-doping on the B-sites (Ti^{4+}) of the host crystal $SrTiO_3$, while adjusting the over-all valency by simultaneous doping of non-magnetic La^{3+}-ions on the A-sites. For increased doping a transition from quantum-paraelectric to relaxor-ferroelectric behaviour is expected. Polycrystalline samples of $Sr_{1-x}La_xTi_{1-x}Fe_xO_3$ (x = 0.01, 0.05, 0.10) were prepared by a standard ceramic process and characterized by x-ray diffractometry, REM-EDX and measurements of magnetic susceptibility. Relaxor-states and field dependent dielectric properties of the sample-compound were studied by broadband dielectric spectroscopy. The measurements were performed down to low temperatures using an impedance-analyser and a standard two electrode parallel-plate capacitor geometry.

TT 37.8 Thu 14:00 Poster A

Finite-density corrections to the Unitary Fermi gas: A lattice perspective from DMFT — •Antonio Privitera[1,2], Massimo Capone[1], and Claudio Castellani[1] — [1]CRS SMC, CNR-INFM and Dipartimento di Fisica, Universita di Roma La Sapienza, Piazzale Aldo Moro 2, I-00185 Roma, Italy — [2]Institut für Theoretische Physik, Johann Wolfgang Goethe-Universität, 60438 Frankfurt am Main, Germany

We investigate the approach to the universal regime of the dilute unitary Fermi gas as the density is reduced to zero in a lattice model [1]. To this end we study chemical potential, superfluid order parameter and internal energy of the attractive Hubbard model in three different lattices: a cubic lattice, a Bethe lattice with a semicircular DOS, and a lattice gas with parabolic dispersion and a sharp energy cutoff. The model is solved using Dynamical Mean-Field Theory, that treats directly the thermodynamic limit and arbitrarily low densities, eliminating finite-size effects. The evolution to the low-density limit is smooth and it does not allow to define an unambiguous low-density regime. Such finite-density effects are significantly reduced using the lattice gas, and they are maximal for the cubic lattice. Even though DMFT is bound to reduce to the more standard static mean field in the limit of zero density due to the local nature of the self-energy and of the vertex functions, it compares well with accurate Monte Carlo simulations down to the lowest densities accessible to the latter [2].

[1]A. Privitera *et al.*, arXiv:0909.1298
[2] A. Bulgac *et al.*, Phys. Rev. A **78**, 023625 (2008)

TT 37.9 Thu 14:00 Poster A

Lattice small polaron theory for Bose-Fermi mixtures — •Antonio Privitera, Mohammad Reza Bakhtiari, and Walter Hofstetter — Institut für Theoretische Physik, Johann Wolfgang Goethe-Universität, 60438 Frankfurt am Main, Germany

We present a generalization of small polaron theory describing polaronic effects in strongly imbalanced Bose-Fermi mixtures in the case where both Bosons and Fermions are trapped in the same optical lattice [1]. This allows us to estimate how the hopping of a single Fermionic impurity immersed in a large BEC is renormalized for different temperatures and coupling regimes. The presence of a lattice strongly affects the properties of the Bogolubov modes, which play the same role as phononic excitations in the context of condensed matter physics. We show that these lattice effects cannot be simply included within a mass renormalization, even at zero temperature. Finally we discuss the limits of validity of the approach and compare our results with recent experiments on strongly imbalanced Bose-Fermi mixtures.

[1] T. Best *et al.*, Phys. Rev. Lett. **102**, 030408 (2009)

TT 37.10 Thu 14:00 Poster A

Canted Antiferromagnetic Order of Imbalanced Fermi-Fermi Mixtures in Optical Lattices: a Dynamical Mean-Field Perspective — •Irakli Titvinidze[1], Michiel Snoek[2], and Walter Hofstetter[1] — [1]Institut für Theoretische Physik, Johann Wolfgang Goethe-Universität, 60438 Frankfurt am Main, Germany — [2]Institute for Theoretical Physics, Valckenierstraat 65, 1018 XE Amsterdam, The Netherlands

We investigate antiferromagnetic order of repulsively interacting fermionic atoms in two- and three-dimensional optical lattices by means of Dynamical Mean-Field Theory. Special attention is paid to the case of an imbalanced mixture, in which case the antiferromagnetism is canted, i.e. the staggered component perpendicular to the applied field. We take into account the presence of the underlying harmonic trap, both within a local density approximation and by performing full Real-Space DMFT [1] calculations. No Stoner instability towards a ferromagnetic phase is found. Phase separation is only observed for large repulsion and strong imbalance.

TT 37.11 Thu 14:00 Poster A

Local mean-field theory for quantum phase transitions in disordered Bose-Hubbard systems — •Astrid Elisa Niederle and Heiko Rieger — Theoretical Physics, Saarland University, D-66041 Saarbrücken

The Bose-Hubbard model represents a theoretical approach to study Bose-Einstein condensates in diverse kinds of optical lattices. We focus on the influence of disorder in these systems and especially the phase transitions in dependence of the system parameters and study the properties of a Bose-Einstein condensate in an optical trap with an equally distributed disorder in the on-site energies. We develop a local mean-field approach to investigate the transitions between the three competing phases (superfluid, Mott insulator, Bose glass), which can be observed in dependence of the system parameters. Beside the global changes of the phase diagram in dependence of the geometry, finite size effects are discussed.

TT 37.12 Thu 14:00 Poster A

Variational Cluster Approach for Bosonic Systems — •Stephan Filor and Thomas Pruschke — Institut für Theoretische Physik, Universität Göttingen

We propose a variational cluster ansatz to bosonic systems which is based on Potthoff's self-energy functional approach. To find a suitable cluster approximation it takes advantage of certain properties of the Baym-Kadanoff formalism which treats the grand canonical potential as a functional of the Green's function respectively the self-energy.

In our ansatz the bosonic operators are used within the Nambu formalism to allow for a condensed phase, for which we additionally introduce a reservoir coupled to the cluster sites as a variational parameter. The approach is tested for simple lattices.

TT 37.13 Thu 14:00 Poster A

Dynamical mean-field theory for bose-fermi mixtures in optical lattices — •Krzysztof Byczuk[1] and Dieter Vollhardt[2] — [1]Institute of Theoretical Physics, University of Warsaw*, ul. Hoza 69, PL-00-681 WARSZAWA — [2]Theoretical Physics III, Center for Electronic Correlations and Magnetism*, Institute of Physics, University of Augsburg*, D-86135 Augsburg, Germany

We derive a dynamical mean-field theory for mixtures of interacting bosons and fermions on a lattice (BF-DMFT) [1,2]. The BF-DMFT is a comprehensive, thermodynamically consistent framework for the theoretical investigation of Bose-Fermi mixtures and is applicable for arbitrary values of the coupling parameters and temperatures. It becomes exact in the limit of high spatial dimensions d or coordination number Z of the lattice. In particular, the BF-DMFT treats normal and condensed bosons on equal footing and thus includes the effects caused by their dynamic coupling. Using the BF-DMFT we investigate two different interaction models of correlated lattice bosons and fermions, one where all particles are spinless (model I) and one where fermions carry a spin one-half (model II). In model I the local, repulsive interaction between bosons and fermions can give rise to an attractive effective interaction between the bosons. In model II it can also lead to an attraction between the fermions.

[1] K. Byczuk and D. Vollhardt, Phys. Rev. B 77, 235106 (2008)
[2] K. Byczuk and D. Vollhardt, Ann. Phys. (Berlin) 18, 622 (2009)

TT 37.14 Thu 14:00 Poster A

Phase diagrams for spin-1 bosons in an optical lattice — •Ming-Chiang Chung — National Center for Theoretical Sciences, Hsinchu, Taiwan

In this talk, the phase diagrams of a polar spin-1 Bose gas in a three-dimensional optical lattice with linear and quadratic Zeeman effects both at zero and finite temperatures are obtained within mean-field theory. The phase diagrams can be regrouped to two different parameter regimes depending on the magnitude of the quadratic Zeeman effect Q. For large Q, only a first-order phase transition from the nematic NM phase to the fully magnetic FM phase is found, while in the case of small Q, a first-order phase transition from the nematic phase to the partially magnetic PM phase, plus a second-order phase transition from the PM phase to the FM phase is obtained. If a net magnetization in the system exists, the first-order phase transition causes a coexistence of two phases and phase separation: for large Q, NM and

FM phases and for small Q, NM and PM phases. The phase diagrams in terms of net magnetization are also obtained.

TT 37.15 Thu 14:00 Poster A

Multiple condensed phases in interacting Bose systems — •Michael Männel[1], Klaus Morawetz[2,3], Pavel Lipavský[4,5], and Michael Schreiber[1] — [1]Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany — [2]Department Physical Engineering, Münster University of Applied Science, 48565 Steinfurt, Germany — [3]International Center of Condensed Matter Physics, University of Brasilia, 70904-970, Brasilia-DF, Brazil — [4]Institute of Physics, Academy of Sciences, Cukrovarnická 10, 16253 Prague 6, Czech Republic — [5]Faculty of Mathematics and Physics, Charles University, Ke Karlovu 3, 12116 Prague 2, Czech Republic

We investigate a Bose gas with finite-range interaction using a scheme to eliminate unphysical processes in the T-matrix approximation. In this way the corrected T-matrix becomes suitable to calculate properties below the critical temperature. For attractive interaction, an Evans-Rashid transition occurs between a quasi-ideal Bose gas and a BCS-like phase with a gaped dispersion. The gap decreases with increasing density and vanishes at a critical density where the single-particle dispersion becomes linear for small momenta indicating Bose-Einstein condensation. The investigation of the pressure shows however, that the mentioned quantum phase transitions might be inaccessible due to a preceding first order transition.

TT 37.16 Thu 14:00 Poster A

Three-body interacting cold polar molecules in one dimension — •Gregor Foltin[1], Andreas Läuchli[2], and Kai Phillip Schmidt[1] — [1]Lehrstuhl für Theoretische Physik I, Otto-Hahn-Strasse 4, TU Dortmund, 44221 Dortmund, Germany — [2]Max Planck Institut für Physik komplexer Systeme, Nöthnitzerstrasse 38, 01187 Dresden, Germany

It has been proposed recently [1] that cold polar molecules in an optical lattice can be tuned to a regime of strong three-body interactions. It is therefore an interesting question what kind of quantum phases are stabilized in a system of hardcore bosons interacting via two- and three-body forces. The effects of pure but longer range three-body interactions has been studied on the square lattice giving a cascade of solid and also supersolid phases [2]. The leading two- and three-body term has been investigated in one dimension [3] and on the honeycomb model [4]. Here we are interested in the effects of subleading terms for the one-dimensional case. To this end we use a classical approach, fermionic mean-field theory, and exact diagonalizations in order to map out the zero-temperature phase diagram.

[1] H.P. Büchler, A. Micheli, P. Zoller, Nature Physics 3, 726 (2007).

[2] K.P. Schmidt, J. Dorier, and A. Läuchli, Phys. Rev. Lett. 101, 150405 (2008).

[3] B. Capogrosso-Sansone, S. Wessel, H.P. Büchler, P. Zoller, G. Pupillo, Phys. Rev. B 79, 020503(R) (2009).

[4] L. Bonnes, H.P. Büchler, and S. Wessel arXiv:0911.0312.

TT 37.17 Thu 14:00 Poster A

Vortices in rotating quantum droplets — •Henri Saarikoski[1,4], Ari Harju[2], Matti Manninen[3], and Stephanie Reimann[1] — [1]Mathematical Physics, Lund University, SE-22100 Lund, Sweden — [2]Department of Applied Sciences and Helsinki Institute of Physics, P.O. Box 4100, FI-02015 HUT, Finland — [3]Nanoscience Center, Department of Physics, FI-40014 University of Jyväskylä, Finland — [4]Present address: University of Regensburg, 93040 Regensburg

The structure of rotating quantum systems is fundamentally determined by how these systems carry angular momentum. A priori very different systems share some basic properties that appear universal. Examples are the reduced dimensionality due to rotation and formation of vortices, as well as composites of particles and vortices. These phenomena may occur both in bosonic and fermionic systems and regardless of the form of the interparticle potential. Due to this universality, rotating quantum liquids can be described theoretically by using similar concepts and analogous vocabulary.

Our review work aims to give a unified view of the progress in the fields of finite rotating quantum systems, setting the emphasis on the structural properties of the many-body state. The focus will be on the theoretical results and development of many-body techniques used in this context. We highlight the similarities between rotating bosonic and fermionic systems, taking the analogy between electronic states in quantum dots, and bosonic states in rotating Bose-Einstein condensates as a recurring example.

TT 37.18 Thu 14:00 Poster A

Exploring magnetic solitons using DMRG — Anton Wöllert and •Andreas Honecker — Institut für theoretische Physik - Friedrich Hund Platz 1, Göttingen, Germany

We study the anisotropic ferromagnetic frustrated Heisenberg spin-1/2 chain out of equilibrium. The aim is to find solitonic structures using the adaptive time dependent density matrix renormalization group (t-DMRG). This should be achieved by quenching the system from an excited state and examining the real time evolution. Especially parts of the phase diagram are analyzed, where solitons can be observed in the classical model.

TT 37.19 Thu 14:00 Poster A

Quenches in three dimensional ultracold bosonic systems — •Akos Rapp and Achim Rosch — Institut für Theoretische Physik, Universität zu Köln, 50937 Köln

Ultracold atoms provide clean systems to study phenomena related to the competition between kinetic, interaction and confinement energies under flexible experimental conditions. Confinement leads to phases which are absent in a homogeneous system, and the "Mott cake" structure in a strongly repulsing bosonic system is probably the most spectacular example. We study the bosonic Hubbard model in a three dimensional harmonic trap combining rapid quenches with adiabatic changes of the system parameters. Using a combination of the bosonic Gutzwiller approximation and high-temperature expansions we analyze how much entropy is generated during the quenches and investigate which phases can be stabilized in the trap.

TT 37.20 Thu 14:00 Poster A

Probing Local Relaxation of Cold Atoms in Optical Superlattices — •Andreas Flesch[1,2], Marcus Cramer[3], Ian P. McCulloch[4], Jens Eisert[3,5], and Ulrich Schollwöck[1,6] — [1]Institut für Theoretische Physik C, RWTH Aachen University, 52056 Aachen — [2]Institut für Festkörperforschung and Institute for Advanced Simulation, Forschungzentrum Jülich, 52425 Jülich — [3]Institute for Mathematical Sciences, Imperial College London, SW7 2PE London — [4]School of Physical Sciences, The University of Queensland, Brisbane, QLD 4072 — [5]Institute for Physics and Astronomy, University of Potsdam, 14476 Potsdam — [6]Department of Physics and Arnold Sommerfeld Center for Theoretical Physics, Ludwig-Maximilians-Universität München, 80333 München

Ultracold atoms in optical superlattices are a promising candidate for the experimental investigation of relaxation processes in coherent non-equilibrium dynamics of quenched quantum systems. We study the evolution of a particular initial state prepared in a superlattice structure under a Bose-Hubbard Hamiltonian in the entire range of interaction strengths using mainly a t-DMRG approach [1,2]. By the investigation of certain correlation functions, we show that the proposed setup allows to experimentally probe signatures of local relaxation of subsystems in non-equilibrium dynamics. First experimental results [3] are in a very good agreement with the theoretical predictions.

[1] M. Cramer et al., PRL 101, 063001 (2008)

[2] A. Flesch et al., PRA 78, 033608 (2008)

[3] S. Trotzky and I. Bloch, private communication

TT 37.21 Thu 14:00 Poster A

Spin Coherence in Graphene — •Matthias Droth and Guido Burkard — Universität Konstanz, 78464 Konstanz, Germany

Spin relaxation in a quantum dot can occur due to interaction with nuclear spins or phonons. Since $\mu_N \ll \mu_{e^-}$ the former coupling is supressed for typical magnetic fields slightly above the mT regime such that phonon coupling is the dominant effect. For a rectangular dot on a graphene nano ribbon we calculate T_1 assuming the relaxation to occur via spin-orbit and electron-phonon interaction as proposed in [1]. In order to obtain the spectrum and density of states of the relevant acoustic phonons we start from a continuum model and derive the dispersion relations for in-plane and out-of-plane acoustic phonons. Due to open boundary conditions at the ribbon edges the usual q^2 dependence for out-of-plane modes in bulk is cut off at the zone center where we find a linear dispersion. The transverse and longitudinal sound velocities of the in-plane modes match well with literature values [2].

[1] A. V. Khaetskii, Y. V. Nazarov; Physical Review B **64**, 2001

[2] L. A. Falkovsky; arXiv:0802.0912v1

TT 37.22 Thu 14:00 Poster A

Signatures of Klein tunneling in the Aharonov-Bohm ef-

fect in graphene rings — •Jörg Schelter[1], Dan Bohr[2], and Björn Trauzettel[1] — [1]Department of Theoretical Physics and Astrophysics, University of Würzburg, D-97074 Würzburg, Germany — [2]Department of Physics and Astronomy, University of Basel, CH-4056 Basel, Switzerland

We numerically investigate the effect of Klein tunneling on the Aharonov-Bohm oscillations in graphene rings using a tight-binding model with nearest neighbor couplings. In order to introduce Klein tunneling into this system, we apply an electrostatic potential to one of the arms of the ring, such that this arm together with the two adjacent leads form either a $nn'n$- or npn-junction. The former case corresponds to normal tunneling and the latter case to Klein tunneling.

We find that the transmission properties strongly depend on the smoothness of the two pn-junctions in series. In particular, for sharp junctions the amplitude profile is symmetric around the charge neutrality point in the gated arm, whereas for smooth junctions the Aharonov-Bohm oscillations are strongly suppressed in the Klein tunneling regime.

TT 37.23 Thu 14:00 Poster A

Work function engineering and doping of graphene — •Burkhard Sachs[1], Tim Wehling[1], Alexander Lichtenstein[1], and Mikhail Katsnelson[2] — [1]1. Institut für Theoretische Physik, Universität Hamburg, Jungiusstraße 9, D-20355 Hamburg, Germany — [2]Institute for Molecules and Materials, Radboud University Nijmegen, NL-6525 AJ Nijmegen, The Netherlands

Realistic graphene samples are always subject to external perturbations, e.g., impurities, adsorbates or strains. We investigate doping effects on graphene originating from molecular adsorbates and strains by using density functional theory calculations. The impact of work function variations on real graphene devices is discussed and compared to other doping mechanisms, including chiral midgap states for monovalent adsorbates. Screening effects for adsorbate induced dipole moments are considered with the example of water molecules.

TT 37.24 Thu 14:00 Poster A

Bistability and oscillatory motion of natural nano-membranes appearing within monolayer graphene on silicon dioxide investigated by scanning tunneling microscopy — •Marco Pratzer, Torge Mashoff, Viktor Geringer, Marcus Liebmann, and Markus Morgenstern — II. Physikalisches Institut B and JARA-FIT, Otto-Blumenthal-Straße, RWTH Aachen, 52074 Aachen

The truly two-dimensional material graphene is an ideal candidate for nanoelectromechanics due to its large strength and mobility. Monolayer graphene flakes were prepared by mechanical exfoliation on a SiO_2 substrate. Using scanning tunneling microscopy at $T = 4.8\,\mathrm{K}$ we found natural nano-membranes within the intrinsic rippling of the graphene with a size down to 3 nm. The membranes could be lifted either reversibly or hysteretically by the tip of the scanning tunneling microscope depending on the interacting forces of substrate, graphene and tip. Atomically resolved STM images show different atomic arrangements in compressed and relaxed graphene areas. The clamped-membrane model including van-der-Waals and dielectric forces explains the results quantitatively. By applying an AC bias voltage we could oscillate the nano-membranes, which might lead to a completely novel approach to controlled quantized oscillations or single atom mass detection.

TT 37.25 Thu 14:00 Poster A

Valley degeneracy of graphene nanoribbons — •Franziska Maier and Guido Burkard — Universität Konstanz, D-78457 Konstanz, Germany

Graphene quantum dots are fabricated by cutting the desired shape out of graphene sheets. Their electronic properties are highly influenced by the shape of lattice termination and effects due to local electric fields and strained bonds.

To allow the design of quantum dots showing specific electronic properties, we investigated the dispersion relation and valley degeneracy of graphene nanoribbons cut in arbitrary directions regarding the lattice. Therefore boundary conditions in form of a local linear restriction on the spinor wave function [1] were used.

[1] A. Akhmerov and C.W.J. Beenakker, Phys. Rev. B **77**, 085423 (2008).

TT 37.26 Thu 14:00 Poster A

Low Energy Effective Theory for Nanotubes with Spin Orbit coupling — •Stephan Weiss[1], Frederik Treue[1], Emmanuel Rashba[2,3], and Karsten Flensberg[1] — [1]Niels Bohr Institute & Nano-Science Center, University of Copenhagen — [2]Department of Physics, Harvard University, Cambridge, Massachusetts 02138, USA — [3]Center for Nanoscale Systems, Harvard University, Cambridge, Massachusetts 02138, USA

Spin orbit coupling in nanotubes has motivated experimental and theoretical research activities recently. Due to the interplay between curvature and atomic SO coupling, the single particle spectrum exhibits a finite gap at zero magnetic field between the two Kramers doublets. We present different approaches in order to derive the low energy effective Hamiltonian [1]. First based on symmetry arguments we derive the Hamiltonian. This settles the number of free coupling constants as well as the general form of the Hamiltonian. In a second approach, we employ a four band tight binding calculation for the π and σ bands of graphene and include curvature between the bonds and atomic spin orbit coupling in lowest order perturbation theory. We are able to give estimates for the coupling constants, based on the known tight binding parameters for plane graphene. A fully numerical approach, which involves a Hückel approximation on the overlap integrals between neighboring atoms is used to calculate the SO coupling parameter for different chiralities of nanotubes and the zero field gap for electrons and holes.

[1] S. Weiss, F. Treue, E.I. Rashba, and K. Flensberg, in preparation.

TT 37.27 Thu 14:00 Poster A

Quasi-continuous generation of structual defects in graphene — •Verena Martin, Michael Krieger, Johannes Jobst, Daniel Waldmann, and Heiko B. Weber — Universität Erlangen-Nürnberg, Staudtstr. 7, 91058 Erlangen

High-quality epitaxal graphene at low temperatures has metallic conductivity. This regime can be destroyed by the generation of structual defects. In our experiment, we carry out resistance measurements at low temperatures ($T \sim 4\,\mathrm{K}$) and slowly increase the amount of disorder by ion bombardement *in situ*. The implantation dose can be limited down to ~ 100 per μm^2 ion impacts per implantation step. An increase of the resistance by several orders of magnitude with increasing implantation dose is found. The transition between the metallic and the insulating regime is discussed.

TT 37.28 Thu 14:00 Poster A

Wave-packet propagation in graphene — •Viktor Krückl[1] and Tobias Kramer[1,2] — [1]Institut für Theoretische Physik, Universität Regensburg, 93040 Regensburg — [2]Department of Physics, Harvard University, Cambridge, MA 02138, USA

The unique electronic structure of graphene generates remarkable phenomena like the anomalous quantum Hall effect or the zitterbewegung. Our main focus are time-dependent effects in semiconductors with a major emphasis on zero gap semiconductors like graphene. We investigate the time evolution of wave packets in a perpendicular magnetic field and report about the collapses and revivals of initially localized cyclotron wave packets[1]. For complex setups we present an algorithm which is capable of solving the time-dependent scattering problem in arbitrary shaped potentials and magnetic fields. With this we study the scattering of wave-packets on ripples and impurities.

[1] Viktor Krueckl and Tobias Kramer, New J. Phys. 11 093010 (2009)

TT 37.29 Thu 14:00 Poster A

Scanning tunneling spectroscopy of graphene islands on Ir(111) — •Dinesh Subramaniam[1], Viktor Geringer[1], Mike Pezzotta[1], Marcus Liebmann[1], Marco Pratzer[1], Carsten Busse[2], Thomas Michely[2], and Markus Morgenstern[1] — [1]II. Physikalisches Institut B, Otto-Blumenthal-Straße, RWTH Aachen and JARA-FIT, 52074 Aachen — [2]II. Physikalisches Institut, Universität zu Köln, Zülpicher Straße 77, 50937 Köln

Epitaxial graphene islands are produced by ethylene deposition at room Temperature and subsequent annealing to 1320 K [1]. dI/dU curves on Ir(111) and graphene islands look quite similar, while dI/dU images provide confined states within the islands in addition to standing waves around the islands. Edge states are observed at around +50 mV sample voltage and are additionally probed by magnetoresistance curves using a spin-polarized tip.

[1] J. Coraux, A.T. N Diaye, M. Engler, C. Busse, D. Wall, N. Buckanie, F.M. Heringdorf, R. van Gastel, B. Poelsema and T. Michely, New Journal of Physics 11, 023006 (2009)

TT 37.30 Thu 14:00 Poster A

Ballistic transport and counting statistics on disordered graphene — •Alexander Schüssler[1], Mikhail Titov[2,3], Pavel M. Ostrovsky[1], Igor V. Gornyi[1,2], and Alexander D. Mirlin[1,2,4] — [1]Institut für Nanotechnologie, Karlsruhe Institute of Technology, 76021 Karlsruhe, Germany — [2]DFG Center for Functional Nanostructures, Karlsruhe Institute of Technology, 76128 Karlsruhe, Germany — [3]School of Engineering and Physical Sciences, Heriot-Watt University, Edinburgh EH14 4AS, UK — [4]Institut für Theorie der kondensierten Materie, Karlsruhe Institute of Technology, 76128 Karlsruhe, Germany

The full counting statistics for the charge transport through an undoped graphene sheet in the presence of strong potential impurities is studied. We develop two analytical approaches based on the scattering theory and on the Green function formalism, respectively. Treating the scattering off the impurity in the s-wave approximation, we calculate the impurity correction to the cumulant generating function. This correction is universal provided the impurity strength is tuned to a resonant value. In particular, the conductance of the sample acquires a correction of $16e^2/2\pi h$ per resonant impurity. Our results are fully supported by numerical simulations. We further analyze the crossover to the diffusive behavior with increasing system length and calculate the counting statistics in the latter regime for the case of random potential that does not mix two graphene valleys.

[1] M. Titov et al arXiv: 0908.3793

TT 37.31 Thu 14:00 Poster A

Spectral properties of coupled cavity arrays in one dimension — •Michael Knap, Enrico Arrigoni, and Wolfgang von der Linden — Institute of Theoretical and Computational Physics, Graz University of Technology, 8010 Graz, Austria

The experimental progress in controlling quantum optical and atomic systems, which has been achieved over the last few years, prompted ideas for new realizations of strongly-correlated many body systems, such as light-matter systems [1]. These systems consist of photons confined in optical cavities, which interact strongly with atomic-like structures. Similarly to the Bose-Hubbard model the light-matter systems exhibit a quantum phase transition from Mott to superfluid. Yet the physics of the latter is far richer as two types of particles are present.

We use the variational cluster approach (VCA) [2] to study the physics of light-matter models. This method allows to treat systems of large size and at zero temperature. In particular we evaluate the spectral functions of both photons as well as atomic-excitations [3]. Based on this information we are able to introduce polariton quasiparticles as appropriate, wave vector and filling dependent linear combinations of photons and atomic-like particles. Spectral properties are evaluated for the polariton particles and the weights of their constituents are analyzed. In addition we discuss improvements of VCA, more specifically the Q-matrix formalism, to deal with bosonic excitations.

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[3] M. Knap, E. Arrigoni, and W. von der Linden, arXiv:0912.4459.