TT 4: Disordered Quantum Systems

Time: Monday 9:30–11:15 Location: HSZ 204

Invited Talk TT 4.1 Mon 9:30 HSZ 204

Towards an *ab-initio* theory of Anderson localization with correlated electrons — •Liviu Chioncel — Uni. Augsburg

Great progress has been made in recent years towards understanding the properties of disordered electronic systems. This is made possible by recent advances in quantum effective medium methods which include Dynamical Mean-Field Theory and the Coherent Potential Approximation, and their cluster extension, the Dynamical Cluster Approximation. The recently developed typical medium dynamical cluster approximation captures disorder-induced localization and provides an order parameter for the Anderson localized states. We present an overview of various recent applications of the typical medium single-site and dynamical cluster approximation to the Hubbard model, and its combination to realistic systems in the framework of Density Functional Theory.

TT 4.2 Mon 10:00 HSZ 204

Electrically Biased Resonators for Investigations of Dielectric Low Temperature Properties of Amorphous Solids — •Benedikt Frey, Marcel Haas, Marius Lutz, Diana Körner, Andreas Fleischmann, Andreas Reiser, and Christian Enss — Kirchhoff-Institute for Physics , Heidelberg University, D-69120 Heidelberg

The low temperature properties of amorphous solids are governed by atomic tunneling systems, which can be described as two-level systems (TLS) with a distribution of their energy splitting E, as assumed by the phenomenological standard tunneling model. Recent interest in these systems due to their deteriorative effects on the performance of superconducting quantum devices have been leading to novel experimental investigations of atomic tunneling systems also driven by novel measurement techniques.

We use microfabricated superconducting resonators in a bridge-type setup to study the dielectric rf-response of the amorphous sample in the presence of an electric bias field. The bias field modifies the energy splitting E of a TLS and allows to probe different regions of the TLS distribution. This technique enables various opportunities for studying TLS more in-depth. We see a correlation between the dielectric loss and the bias field sweep rate, which can be well described within a theory based on Landau-Zener transitions. Moreover, a desaturation of the TLS occupation number also occurs, when noise is used as the bias signal. These results are compared to detailed numerical simulations, showing in general a good agreement.

TT 4.3 Mon 10:15 HSZ 204

Dielectric Polarization Echoes of Glasses Containing Large Nuclear Quadrupole Moments — •Andreas Schaller, Andreas Reiser, Andreas Fleischmann, and Christian Enss — Kirchhoff-Institute for Physics, Heidelberg University, D-69120 Heidelberg

Many properties of amorphous solids at low temperatures can be explained by the standard tunneling model, which is based on atomic tunneling systems, described as two-level systems. Tunneling systems with an electric dipole moment couple resonantly to electric fields and can thus be studied using dielectric two-pulse polarization echoes to learn about their dynamics and coherence. Measurements of the dielectric constant, sound velocity, and dielectric polarization echoes of glasses containing atoms carrying nuclear quadrupole moments revealed unexpected characteristics, such as magnetic field dependencies, which are not observed in glasses without nuclear moments. Furthermore, measurements of the dielectric constant of glasses with large nuclear quadrupole moments point towards a so far unconsidered relaxation process.

We present results of dielectric two-pulse polarization echo measurements carried out on different multi-component glasses and polymers containing large nuclear quadrupole moments. For all these samples the two-pulse-echo amplitude is small and the decay occurs on a shorter timescale compared to samples containing no or just small nuclear quadrupole moments. We compare the results to simulations obtained by a Monte Carlo method approach.

TT 4.4 Mon 10:30 HSZ 204

Ab initio typical medium theory of substitutional disorder — •Andreas Östlin[1], Yi Zhang[2,3], Hanna Terletska[4], Florian Beiuseanu[5], Voicu Popescu[6], Krzysztof Byczuk[7], Levente Vitos[8,9,10], Mark Jarrell[2], Dieter Vollhardt[1], and Liviu Chioncel[1,11] — [1]University of Augsburg, Augsburg, Germany — [2]Louisiana State University, Baton Rouge, USA — [3]Kavli Institute for Theoretical Sciences, Beijing, China — [4]Middle Tennessee State University, Murfreesboro, USA — [5]University of Oradea, Oradea, Romania — [6]Sophie-Scholl-Gymnasium Oberhausen, Oberhausen, Germany — [7]University of Warsaw, Warszawa, Poland — [8]KTH Royal Institute of Technology, Stockholm, Sweden — [9]Uppsala University, Uppsala, Sweden — [10]Research Institute for Solid State Physics and Optics, Budapest, Hungary — [11]Augsburg Center for Innovative Technologies, Augsburg, Germany

By merging single-site typical medium theory with density functional theory we introduce a self-consistent framework for electronic structure calculations of materials with substitutional disorder which takes into account Anderson localization. The scheme and details of the implementation are presented and applied to the hypothetical alloy Li(c)Be(1-c), and the results are compared with those obtained with the coherent potential approximation. Furthermore we demonstrate that Anderson localization suppresses ferromagnetic order for a very low concentration of (i) carbon impurities substituting oxygen in MgO(1-c)C(c), and (ii) manganese impurities substituting magnesium in Mg(1-c)Mn(c)O for the low-spin magnetic configuration.

TT 4.5 Mon 10:45 HSZ 204

Slow Dynamics in the Charge-Glass Forming Organic Conductors θ-(BEDT-TTF)$_2$MM′(SCN)$_4$ — •Tatjana Thomas[1], Yassine Agarmani[1], Tim Thyzel[1], Hungwei Sun[1], Kenichiro Hashimoto[2], Takahiko Sasaki[2], Hiroshi Yamamoto[3], and Jens Müller[1] — [1]Institute of Physics, Goethe University Frankfurt, Germany — [2]Institute for Materials Research, Tohoku University, Japan — [3]Institute for Molecular Science, Okazaki, Japan

The organic charge-transfer salts θ-(ET)$_2$MM′(SCN)$_4$ are considered as model systems to study strongly correlated electron systems under the influence of geometric frustration. Due to strong Coulomb interactions the system exhibits a charge ordering transition, which can be kinetically avoided by fast cooling resulting in a charge-glass state without long-range order [1]. The required cooling rate depends on the degree of charge frustration, where a higher frustration on the triangular lattice within the conducting layers promotes the charge-glass forming ability [2]. Fluctuation spectroscopy has proven to be a powerful tool to study the charge carrier dynamics at low frequencies [3], which have shown to become very slow and heterogeneous when approaching the glass transition, similar to conventional glass-forming liquids [4]. Here, we present systematic noise studies on three compounds MM′=CsCo, RbZn, TlZn with high, medium and low frustration, respectively. From the power spectral density we extract characteristic energies and time scales dominating the resistance noise and compare the results with the quenched states.

[1] Adv. Mater. **29**, 1601979;
[2] JPSJ **83**, 083602
[3] Crystals **8**, 166
[4] Science **357**, 1381

TT 4.6 Mon 11:00 HSZ 204

Universal quantum glass transition on the Bethe lattice — •Izabella Lovas[1], Catalin Pascu Moca[2,3], and Gergely Zarand[2] — [1]Technical University of Munich, Garching, Germany — [2]Budapest University of Technology and Economics, Budapest, Hungary — [3]University of Oradea, Oradea, Romania

We study the Coulomb glass behavior emerging from the interplay of interactions and disorder, by examining a model of spinless fermions at half filling on the Bethe lattice. We consider the limit of infinite coordination number, where we combine dynamical mean field theory with a Hartree-Fock approximation to investigate the glass transition and the properties of the glassy phase in the presence of full replica symmetry breaking. This approach allows us to study the opening of the Efros-Shklovskii pseudogap in the glassy phase, and also grants us access to the spectral function. In particular, we demonstrate the universal scaling collapse of the pseudogap and the spectral function at close to zero temperatures, where the melting of the glass is governed

by the quantum fluctuations induced by the hopping of fermions between lattice sites. We show that this quantum scaling function differs from the classical scaling function of the thermal phase transition of the spin glass limit. Our results should be relevant for the glassy dynamics observed in Si inversion layers, persisting in the metallic phase.