TT 25: Disordered Quantum Systems

Time: Tuesday 9:30–11:00 Location: H23

TT 25.1 Tue 9:30 H23

Ab-initio typical-medium single-site theory for disordered systems — •Liviu Chioncel[1], Andreas Östlin[2], Levente Vitos[3], Voicu Popescu[4], Krzysztof Byczuk[5], Hanna Terletska[6], Yi Zhang[7], Mark Jarrell[7], and Dieter Vollhardt[2] — [1]ACIT, Uni-Augsburg,Germany — [2]EKM, TP III, Uni-Augsburg,Germany — [3]KTH, Stockhom, Sweden — [4]LMU, Muenchen, Germany — [5]Uni Warsaw, Poland — [6]Middle Tennessee State University, USA — [7]Louisiana State University, USA

We introduce a self-consistent method to perform electronic structure calculations of disordered systems. The approach employs the single-site typical medium theory and is formulated in the language of multiple scattering. We present the formalism, implementation details and applications for realistic materials in which we find characteristics of Anderson localization, i.e., extended states and localized levels in different regions of the impurity bands.

TT 25.2 Tue 9:45 H23

Generalized Dynamical Mean-Field Theory for the Hubbard model with Off-Diagonal Disorder — Yi Zhang[1], •Liviu Chioncel[2], Hanna Terletska[3], Ka Ming Tam[1], Krzysztof Byczuk[4], Mark Jarrell[1], and Dieter Vollhardt[2] — [1]LSU, Baton Rouge, USA — [2]EKM, TP III, Uni-Augsburg,Germany — [3]MTU, Murfreesboro, USA — [4]Uni Warsaw, Poland

We generalize dynamical mean-field theory to describe systems with off-diagonal (hopping) disorder. Our approach is based on the BEB formalism [1], which is an extension of the coherent potential approximation to study alloy systems with off-diagonal disorder. Here, within a cavity method [2] we show that the Hubbard model with bimodal off-diagonal disorder can be mapped onto an effective 2-band model coupled to two independent single impurity Anderson problems. Preliminary numerical results for spectral functions are presented. This method is formally exact in the infinite dimension. It can be extended to model multicomponent alloy systems with diagonal and off-diagonal disorders where electronic correlations are important.

[1] J. A. Blackman, D. M. Esterling, N. F. Berk, Phys. Rev. B 4, 2412 (1971)
[2] A. Georges, G. Kotliar, W. Krauth, M.J. Rozenberg, Rev. Mod. Phys. 68, 13 (1996)

TT 25.3 Tue 10:00 H23

Dynamic Structure Factor of Disordered Coupled-Dimer Heisenberg models — •Max Hörmann and Kai Schmidt — Institut für Theoretische Physik I, Universität Erlangen-Nürnberg, Staudtstraße 7, 91058 Erlangen

We investigate the impact of quenched disorder on the zero-temperature dynamic structure factor of coupled-dimer Heisenberg models on the two-leg ladder and the two-dimensional square lattice bilayer. Using perturbative continuous unitary transformations, huge effects on individual quasiparticles but also on composite bound states and two-quasiparticle continua are observed [1]. This leads to intriguing quantum structures in dynamical correlation functions well observable in spectroscopic experiments.

[1] M. Hörmann, P. Wunderlich, K. P. Schmidt, Phys. Rev. Lett. 121, 167201 (2018)

TT 25.4 Tue 10:15 H23

Exceptional points and nodal-lines in disordered superconductors — •Alexander Zyuzin[1] and Pascal Simon[2] — [1]Aalto University, Espoo, Finland — [2]University Paris Sud, Orsay, France

We consider the effect of disorder on the spectrum of quasiparticles in the point-node and nodal-line superconductors. We show that the interplay of disorder, band-structure anisotropy, and the supercurrent might give rise to the non-Hermitian superconducting phase, where depending on the dimensionality of the system, the nodes in the spectrum are replaced by the bulk Fermi arc or area bounded by the exceptional points or lines, respectively. We first consider a model of the proximity-induced superconductivity in the anisotropic two-dimensional Dirac semimetal. It is shown that disorder leads to a non-Hermitian self-energy contribution resulting in a bulk Fermi arc in the gap function bounded by the exceptional points. We then consider three-dimensional nodal superconductors in the presence of the supercurrent and show that disorder scattering transforms the nodes in the spectrum of quasiparticles into a Fermi area bounded by the exceptional lines.

TT 25.5 Tue 10:30 H23

Microstructured Superconducting Resonator Technique for Measurements of Dielectric Polarization Echoes at Very Short Pulse Separation Times — •Andreas Schaller, Marcel Haas, Robert Haase, Anna Pollithy, Sergey Tsurkan, Matthias Sinnwell, Andreas Reiser, Andreas Fleischmann, and Christian Enss — Kirchhoff-Institute for Physics, Heidelberg University, D-69120 Heidelberg

The anomalous properties of amorphous solids at low temperatures are governed by tunneling systems, which are described as two-level systems in the phenomenological standard tunneling model. However, measurements of the dielectric constant, sound velocity, and dielectric polarization echoes of glasses containing atoms carrying large nuclear quadrupole moments revealed unexpected characteristics, such as magnetic field dependencies, which are not observed in glasses without nuclear quadrupole moments.

We present results of dielectric two-pulse polarization echo measurements carried out on different multicomponent glasses and polymers containing large nuclear quadrupole moments. For all these samples the two-pulse-echo decay occurs on a comparably short timescale. In order to investigate those echo decays on sub-μs times we developed planar microfabricated superconducting resonators. We were able to measure dielectric polarization echoes at unprecedentedly small pulse separation times and could see the flattening off of the polarization amplitude of N-BK7 towards small pulse separation times, as predicted by spectral diffusion theory.

TT 25.6 Tue 10:45 H23

Studying the Dielectric Low Temperature Properties of Amorphous Solids using Biased Resonators — •Benedikt Frey, 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, often described as two-level systems (TLS) with the energy splitting E. Besides the recent interest in these systems, due to their diverse impact on microfabricated quantum devices, such tunneling systems have been studied for many years in amorphous solids and are successfully described in many cases by the phenomenological standard tunneling model.

We use microfabricated superconducting resonators in a bridge-type setup to study the dielectric rf-response of the amorphous substrate in the presence of an electrical bias field. This bias field modifies the energy splitting E of a TLS by coupling to its dipole moment. Consequently, a sweep of the bias field constantly pushes different TLS in resonance with the resonator. We see a correlation between the dielectric function and the bias field sweep rate, which is compared to the simulation results of a Monte Carlo Method approach.