TT 32: Superconductivity: Theory 2

Time: Wednesday 9:30–10:45 Location: HSZ 103

TT 32.1 Wed 9:30 HSZ 103

Josephson lattice model for phase fluctuations of local pairs in copper oxide superconductors — •Sergey Brener[1,2], Malte Harland[1], Alexander Lichtenstein[1], and Mikhail Katsnelson[3] — [1]Universität Hamburg — [2]The Hamburg Centre for Ultrafast Imaging — [3]Radboud Universiteit, Nijmegen, Niederlande

We derive an expression for the effective Josephson coupling from the microscopic Hubbard model. It serves as a starting point for the description of phase fluctuations of local Cooper pairs in $d_{x^2-y^2}$-wave superconductors in the framework of an effective XY model of plaquettes, the Josephson lattice. The expression for the effective interaction is derived by means of the local-force theorem, and it depends on local symmetry-broken correlation functions that we obtain using the cluster dynamical mean-field theory. Moreover, we apply the continuum limit to the Josephson lattice to obtain an expression for the gradient term in the Ginzburg-Landau theory and compare predicted London penetration depths and Kosterlitz-Thouless transition temperatures with experimental data for $YBa_2Cu_3O_{7-x}$.

TT 32.2 Wed 9:45 HSZ 103

Phase sensitive determination of nodal d-wave order parameter in single band superconductors — •Jakob Böker[1], Miguel Sulangi[2], Peter Hirschfeld[2], and Ilya Eremin[1] — [1]Institut für Theoretische Physik III, Ruhr-Universität Bochum, D-44801 Bochum, Germany — [2]Department of Physics, University of Florida, Gainesville, FL 32611

Determining the exact pairing symmetry of a superconducting order parameter remains to be a challenge of great experimental effort. Recently a new method utilizing quasiparticle interference (QPI) measurements based on scanning tunneling spectroscopy was proposed. It states that the momentum-integrated QPI data, antisymmetrized with respect to bias voltage, provides a robust phase sensitive tool to distinguish sign-changing $s_{\pm}$ from sign-preserving s_{++} superconductivity in the iron based superconductors. Here we discuss that the same quantity can be used to visualize the sign-changing character of a single band nodal d-wave order parameter, relevant for the cuprate and likely for the infinite-layer nickelate superconductors. Further, using a realistic approach accounting for Cu-Wannier functions, we model STM data of zinc-doped $Bi_2Sr_2CaCu_2O_{8+\delta}$ to directly compare our theory with experimental results.

TT 32.3 Wed 10:00 HSZ 103

Communal pairing in spin-imbalanced Fermi gases — •Darryl Foo — University of Cambridge

A spin-imbalanced Fermi gas with an attractive contact interaction forms a superconducting state whose underlying components are superpositions of Cooper pairs that share minority-spin fermions. This superconducting state includes correlations between all available fermions, making it energetically favorable to the Fulde-Ferrell-Larkin-Ovchinnikov superconducting state. The ratio of the number of up- and down-spin fermions in the instability is set by the ratio of the up- and down-spin density of states in momentum at the Fermi surfaces, to fully utilize the accessible fermions. We present analytical [EPL 126 67003 (2019)] and complementary Diffusion Monte Carlo results [arXiv:1910.13582] for the state.

TT 32.4 Wed 10:15 HSZ 103

Weak localization corrections to the thermal conductivity in s-wave superconductors — •Lucia Gonzalez Rosado[1,2], Fabian Hassler[2], and Gianluigi Catelani[1] — [1]JARA Institute for Quantum Information (PGI-11), Forschungszentrum Jülich, 52425 Jülich, Germany — [2]JARA Institute for Quantum Information, RWTH Aachen University, 52056 Aachen, Germany

We study thermal conductivity in disordered conventional superconductors, focusing on the weak localization (WL) effect and using a Green's function diagrammatic technique in Nambu space. We obtain the WL correction to the thermal conductivity from the diffusive behavior of the low-energy modes, and calculate it explicitly in two dimensions, both for fixed phase-coherence length and for fixed phase-coherence time. We show that the correction depends in some temperature regimes on an emergent energy scale ε_*. We show that this scale is experimentally measurable for dirty superconductors at high temperatures.

TT 32.5 Wed 10:30 HSZ 103

Experimental consequences of Bogoliubov Fermi surfaces — Clara Johanna Lapp and •Carsten Timm — Institute of Theoretical Physics, Technische Universität Dresden

Superconductors involving electrons with orbital degrees of freedom can have internally anisotropic pairing states that are impossible in single-band superconductors. For example, in even-parity multiband superconductors that break time-reversal symmetry, nodes of the superconducting gap are generically inflated into two-dimensional Bogoliubov Fermi surfaces. The detection and characterization of these quasiparticle Fermi surfaces requires the understanding of their experimental consequences. We derive the low-energy density of states for various nodal structures. Based on this, we calculate the low-temperature forms of the electronic specific heat, the thermal conductivity, the magnetic penetration depth, and the NMR spin-lattice relaxation rate, in the clean limit.