Abstract of Presentation

Presentation Title:

Tailoring Matter on the Molecular Level:
Organic Solids as Models to Study Physics in Reduced Dimensions

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Abstract :

The power of chemistry becomes obvious in the field of organic solids, where desired properties can be realized by molecular engineering. Varying the molecular constituents and the arrangement in the crystal provide the possibility to tune physical properties. The interplay of competing interactions of the charge, spin, orbital and lattice degrees of freedom yields a variety of interesting ground states. The understanding of these fundamental issues is a requirement for any application.

In recent years, it became clear that electronic interactions have a severe influence on the physics of two-dimensional electron systems. Strong Coulomb repulsion drives a transition to a Mott-insulator in a half-filled metal. In the case of a quarter-filled conduction band, for instance, charge order is observed. Stripes and fluctuations seem to be closely connected to superconductivity. Optical spectroscopy is the superior method to investigate the electronic properties. Our findings on organic crystals are compared with theoretical predictions.

Organic conductors of the BEDT-TTF family serve as model systems to study physics in two-dimensions. The Mott transition can be tuned by decreasing the temperature or by increasing the effective electronic correlations. Physical and chemical pressure are proper tools to tune the bandwidth; doping or change of the stoichiometry allow for a variation of the carrier concentration. Close to the Mott transition but still on the metallic side, quasiparticles are observed in the 1/2-filled system κ-(BEDT-TTF)$_2$Cu[N(CN)$_2$]*X* only at temperatures well below 100 K, with a considerable growth of the Drude-like contribution. The itinerant carriers exhibit strong renormalization effects as the metal-insulator transition is approached.

In contrast, the 1/4-filled conductors, like α-(BEDT-TTF)$_2$*M*Hg(SCN)$_4$, are strongly correlated metals close to the charge-order transition; they show a zero-frequency conduction peak already at room temperature, this increases slightly upon cooling. It contains less than 20% of the spectral weight; we assign the shift of the spectral weight from the Drude-peak to higher frequencies to the fluctuations of charge order. The

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compound β″-(BEDT-TTF)$_2$SF$_5$CH$_2$CF$_2$SO$_3$, which is supposed to be even closer to the charge-order transition, exhibits an extremely narrow Drude-like contribution. In the superconducting state (T_c = 5 K) clear indications of the energy gap are observed around 12 cm^{-1}, in good agreement with the BCS prediction.

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