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Tuning Correlations in Low-Dimensional Electron Systems: Fermi liquid versus non-Fermi-liquid behavior in organic conductors

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While the electronic properties of cuprates can be modified by electron or hole doping, organic conductors provide the opportunity to tune the strength of electronic correlations more directly. Varying the bandwidth by (physical or chemical) pressure, the κ-phase BEDT-TTF compounds cross over from a Fermi liquid to a Mott insulator by increasing effective correlations. We systematically investigate the electronic transport properties in organic conductors by dc resistivity and optical measurements in order to extract the temperature and frequency-dependent scattering rate $1/\tau = A(k_BT)^2 + B(\hbar\omega)^2$. We find corresponding temperature and frequency ranges in which the parabolic behaviors are observed. For the first time, we can quantitatively relate the two prefactors ($A/B = 56$) and their enhancement as correlations increase upon approaching the Mott transition. Conceptually low-dimensional organic conductors are also good candidates for quantum criticality because often an ordered state is located next to a metallic state when the system is tuned by pressure. Interestingly both are found, order in the spin as well as in the charge sector. Fermi-liquid behavior observed in the metallic state seems to be limited to certain regions of the phase diagram with non-Fermi-liquid properties evolving as the ordered phase is approached. It is not clear whether these deviations from Fermi liquid behavior are actually a signature of quantum criticality.

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