Pressure-dependent optical investigations of the quantum-spin-liquid Mott insulator $\beta'$-EtMe$_3$Sb[Pd(dmit)$_2$]$_2$

Weiwu Li$^1$, Andrej Pustogow$^1$, Reizo Kato$^2$, Martin Dressel$^1$

$^1$ I. Physikalisches Institut, Universität Stuttgart, Germany, e-mail: dressel@pi1.physik.uni-stuttgart.de
$^2$ RIKEN, Wako, Saitama 351-0198, Japan

The Mott insulator $\beta'$-EtMe$_3$Sb[Pd(dmit)$_2$]$_2$ is an organic quantum spin liquid compound with high frustration due to the triangular lattice. Here we investigate the charge dynamics as the effective correlations are tuned from a genuine Mott insulator to a Fermi-liquid metal with no indications of superconductivity [1].

We have performed systematic pressure- and temperature-dependent infrared studies on single crystals of the quasi-two-dimensional $\beta'$-EtMe$_3$Sb[Pd(dmit)$_2$]$_2$ and follow the evolution of the electronic and lattice properties across the Mott insulator-metal transition. Increasing hydrostatic pressure continuously suppresses the insulating ground state; for $p > 0.6$ GPa, a Drude-like component develops indicating the appearance of coherent quasiparticles at the Fermi level. In the vicinity of the Mott transition, not only the electronic state alters rapidly, but also the vibration modes exhibit pronounced changes in frequency and Fano constant, underlining the strong coupling between lattice and electrons. The anisotropy of the in-plane optical response becomes inverted above 0.6 GPa. The findings are discussed in detail and summarized in a phase diagram comprising different experimental approaches [2].

![Fig. 1. Schematic pressure-temperature diagram of $\beta'$-EtMe$_3$Sb[Pd(dmit)$_2$]$_2$, based on the optical conductivity along the $a$ axis in the limit $\omega \to 0$. The red squares refer to the change in the slope of the dc transport [3] where the temperature of the metal-insulator transition is defined by $d\rho/dT = 0$. The red circles indicate the temperatures, at which the activation energy changes. From our optical experiments we analyze the temperature dependence of the vibration features and shift in spectral weight. The black circles correspond to the maxima of the molecular vibrational mode. The black squares refer to the temperatures where the low-frequency spectral weight is largest. The green triangles represent the temperatures, when the ratio of $\sigma_{ab}/\sigma_{aa}$ crosses unity.](image)

References