Drude response of slow and fast electrons in heavy-fermion compound UNi_2Al_3

Marc Scheffler[a], Julia P. Ostertag[a], Katrin Steinberg[a], Martin Dressel[a], and Martin Jourdan[b]

[a]1. Physikalisches Institut, Universität Stuttgart, 70550 Stuttgart, Germany
[b]Institut für Physik, Universität Mainz, 55099 Mainz, Germany

The characteristic mass enhancement of heavy fermions at low temperatures goes hand in hand with a reduced transport relaxation rate, which can directly be studied with optical spectroscopy: the characteristic Drude roll-off moves to very low frequencies. Here we combine microwave and THz spectroscopy to study thin films of the heavy-fermion compound UNi_2Al_3 at temperatures down to 1 K.
At frequencies of less than 1 cm^{-1} ($\approx$ 30 GHz $\approx$ 124 μeV), a full Drude response indicates the dynamics of the heavy electrons in UNi_2Al_3. This dynamical conductivity is anisotropic along the crystallographic a- and c-axes, in accordance with dc measurements. Surprisingly, at considerably higher frequencies (around 10 cm^{-1}) we observe in the optical conductivity a similar structure that mimics the lower-frequency Drude conductivity in anisotropy, temperature dependence, and absolute value. We interpret these two features as the Drude response of - at low frequencies - correlated, slow electrons and - at higher frequencies - uncorrelated, fast electrons: depending on the optical probing frequency, the conduction electrons appear either heavy or light. These results also shed new light on previous studies of the related material UPd_2Al_3 [1], [2] and heavy-fermion compounds in general.

[1]M. Dressel *et al.*, Phys. Rev. Lett. **88**, 186404 (2002).
[2]M. Scheffler *et al.*, Nature **438**, 1135 (2005).