Optical Response of Sr_2RuO_4 Reveals Universal Fermi-Liquid Scaling and Quasiparticles Beyond Landau Theory

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The relevance of Fermi Liquid (FL) theory in solids is supported by a number of materials. Among transition-metal oxides, Sr_2RuO_4 represents a remarkable example. Indeed, transport properties display low-temperature FL characteristics [1] and there is evidence for p-wave symmetry of its superconducting phase [2] as in superfluid ^3He. FL theory predicts for the inelastic optical relaxation rate to vanish according to the scaling law $1/\tau \propto (\hbar\omega)^2+(p\pi k_BT)^2$, with p=2 [3,4]. Here, we report optical measurements of Sr_2RuO_4 demonstrating that the low-energy relaxation rate ($1/\tau$) of the conduction electrons in this system obeys scaling relations for its frequency (ω) and temperature (T) dependence in accordance with FL theory. We established experimentally for Sr_2RuO_4 the universal value p = 2 and demonstrated remarkable agreement between the experimental data and the theoretically derived scaling functions in the FL regime. We also performed DMFT calculations which yield excellent agreement with the measured optical spectra.

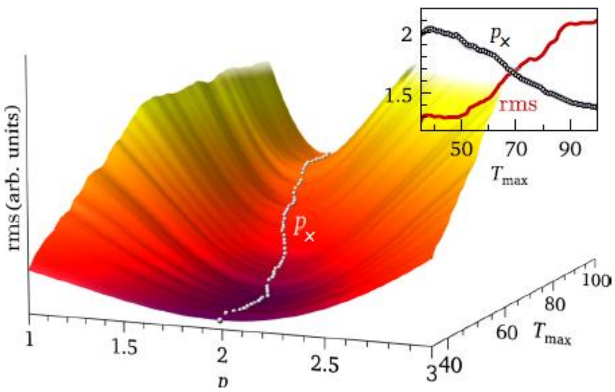

Fig. 1 Root-mean square deviation of the relaxation rate $M_2(\omega,T)$ from a linear dependence in ξ^2_p, for $\hbar\omega \leq 36$ meV and $T \leq T_{max}$, as a function of p and T_{max}. The inset shows the value p_x and the rms at the minimum versus T_{max}. A value $p_x = 2$ is found below $T_{max} \sim 40$ K.

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