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The fate of quasiparticles at a Kondo destroying antiferromagnetic instability

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The prototypical heavy-fermion compound YbRh₂Si₂ exhibits a magnetic-field (B) induced antiferromagnetic quantum critical point (QCP) at $B_c (\perp c) \approx 60$ mT. As inferred from transport and thermodynamic measurements a quantum-critical energy scale, $kBT^*(B)$, indicating a crossover of the Fermi surface, has been established for this system. Upon extrapolating finite-temperature (T) data to $T=0$, one concludes (i) a vanishing of $T^*(B)$ and (ii) an abrupt drop in the (normal) Hall coefficient $RH(B)$ at $B=B_c$, verifying the proposal of a Kondo destroying QCP. The dynamical processes underlying this apparent break-up of the Kondo singlets have been explored by studying the Lorenz ratio L/L_0 as a function of T and B . Here, $L=\rho/w$ is the ratio of the electrical (ρ) and thermal ($w=L_0T/\kappa$) resistivities, with κ being the thermal conductivity and $L_0=(\pi k_B)^2/3e^2$ Sommerfeld's constant. By properly taking care of bosonic (magnon/paramagnon) contributions to the heat current which exist at finite temperature only, extrapolation of the measured data to $T=0$ yields a purely electronic Lorenz ratio $L/L_0=1$ at $B \neq B_c$. At $B \neq B_c$, we extrapolate $L/L_0 \approx 0.9$. Therefore, the Wiedemann Franz (WF) law holds at any value of the control parameter B , except for the field-induced QCP, as is also illustrated by a pronounced heating of the sample when measuring the low - T electrical resistivity in the vicinity of the critical magnetic field. This violation of the WF law is ascribed to scatterings of the electronic heat carriers from fermionic quantum-critical fluctuations, namely those of the Fermi surface.

Biography

Frank Steglich received a Dr. rer. nat. from the University of Goettingen (Germany) in 1969. 1978-1998, he was Professor of Physics at the Technical University of Darmstadt (Germany). In 1996, he was Founding Director of the MPI for Chemical Physics of Solids, Dresden (Germany). After his retirement in 2012, he became Qishi Distinguished Visiting Professor and Director of the Center for Correlated Matter at Zhejiang University, Hangzhou (China) and Distinguished Visiting Professor at the Institute of Physics, Chinese Academy of Sciences, Beijing (China). From 2001 to 2007 he served as Vice President of the German Research Foundation (DFG).

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