Hall effect indicates destruction of large Fermi surface at a heavy-fermion quantum critical point

SILKE PASCHEN, Max Planck Institute for Chemical Physics of Solids, Dresden, Germany

Quantum critical points (QCPs) – phase transitions at absolute zero in temperature – are of great current interest because of their singular ability to influence the finite temperature properties of materials. Recently, heavy-fermion metals have played a key role in the study of antiferromagnetic QCPs. To accommodate the heavy electrons, the Fermi surface of the heavy-fermion paramagnet is larger than that of an antiferromagnet [1]. An important unsolved question concerns whether the Fermi surface transformation at the QCP develops gradually, as expected if the magnetism is of spin density wave type [2], or suddenly as expected if the heavy electrons are abruptly localized by magnetism [3]. Here we report measurements of the low-temperature Hall coefficient ($R_H$) – a measure of the Fermi surface volume – in the heavy-fermion metal YbRh$_2$Si$_2$ upon field-tuning it from an antiferromagnetic to a paramagnetic state. $R_H$ undergoes an increasingly rapid change near the QCP as the temperature is lowered, extrapolating to a sudden jump in the zero temperature limit. We interpret these results in terms of a collapse of the large Fermi surface and of the heavy-fermion state itself precisely at the QCP [4].


In collaboration with: T. Lühmann, S. Wirth, P. Gegenwart, O. Trovarelli, C. Geibel, F. Steglich, P. Coleman, and Q. Si.