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

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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 $YbRh_2Si_2$ 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].

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[2] J. A. Hertz, *Phys. Rev. B* **14**, 1165–1184 (1976); A. J. Millis, *Phys. Rev. B* **48**, 7183– 7196 (1993).

[3] A. Schröder *et al.*, *Nature* **407**, 351- -355 (2000); P. Coleman *et al.*, *J. Phys.: Condens. Matter* **13**, R723–R738 (2001); Q. Si *et al.*, *Nature* **413**, 804–808 (2001).

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