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How Do Heavy Fermions Get Polarized And Die?

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In paramagnetic heavy fermion systems the f-spins dissolve into Kondo singlets and reappear within the Fermi volume, producing a “large” Fermi surface populated by heavy quasiparticles. According to theory, when a very large magnetic field is applied to such a system the Kondo singlets are broken and the fully polarized bare f-spins vanish from the Fermi volume, leaving behind a “small” Fermi surface populated by light quasiparticles. How the system passes from the low-field to the high-field limit is not clear. This talk will discuss recent transport and de Haas van Alphen studies of the archetypal heavy fermion systems CeRu_2Si_2 [1] and YbRh_2Si_2 [2], which are interpreted as showing that the f-electron disappears from the Fermi volume via two successive Lifshitz transitions: in the first transition a majority spin band sinks below the Fermi level, while in the second a new minority spin band appears at the Fermi level. While this interpretation is in accord with recent theoretical work of Kusminskiy et al. [3], it could be criticized on the grounds that only the first of the two postulated Lifshitz transitions have so far been observed.

References:

- [1] R. Daou, C. Bergemann and S.R. Julian, “Continuous evolution of the Fermi surface of CeRu_2Si_2 across the metamagnetic transition,” *Physical Review Letters* **96** (2006) 026401.
- [2] P.M.C. Rourke, A. McCollam, G. Lapertot, G. Knebel, J. Flouquet and S.R. Julian, “Magnetic field dependence of the YbRh_2Si_2 Fermi surface,” arXiv:0807.3970; accepted, *Physical Review Letters*.
- [3] S. Viola-Kusminskiy, K.S.D. Beach, A.H. Castro Neto and D.K. Campbell, “Mean-field study of the heavy fermion metamagnetic transition,” *Physical Review B* **77** (2008) 094419.