UDM 1 – Novel Routes for the Study of Strongly Correlated Electron Systems

Probing the phase diagrams of some Heavy Fermion systems with X-rays

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Heavy-fermions are intermetallic systems containing a lanthanide or actinide element. The strong interaction between the f electrons and the conduction electrons leads to their best known property : a huge renormalization of the effective mass. The systems show Fermi Liquid behavior with an effective mass of the quasiparticles which can be 100 to 1000 times the free electron mass [1]. The corollary of this is also a renormalization of the energy scales to a low temperature. As a consequence the electronic interactions can be relatively easily tuned by the application of an external parameter such as pressure or magnetic field, leading to different ground states, and quantum phase transitions between them where exotic phenomena emerge, such as non-Fermi liquid behavior and unconventional superconductivity,

These phenomena have been extensively studied by macroscopic measurements, usually applying pressure and/or field. Complementary microscopic measurements are highly desirable. Synchrotron radiation is a tool well suited for high pressure studies as the beam can be focused on the tiny samples often used, and high pressure techniques, usually based on the diamond anvil cell, have been extensively developed including at the ESRF. On the other hand the other extreme conditions necessary for Heavy Fermion studies, namely very low temperatures and high magnetic fields, have developed less quickly. Extreme conditions of pressure and temperature have indeed mainly tended towards very high temperatures. However this is changing and suitable conditions of temperature (2K) and field are available. I will describe some recent (and some not so recent) experiments using these facilities to explore these effects. For example the study of the rare earth valence change over the complex phase diagrams in Ce and Yb based heavy fermion systems [2,3], and the consequences for the proposed models of valence fluctuation mediated superconductivity. Another very promising path is the use of XMCD to study ferromagnetic systems, especially the uranium based ferromagnetic superconductors.

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[3] A. Fernandez-Pañella *et al.*, Phys. Rev. B **86**, 125104 (2012).

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