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Ferromagnetic quantum criticality in strongly correlated metals

Quantum critical phenomena fascinate solid-state physicists for quite some time now, as emerging phases of matter can be observed in the vicinity of quantum critical points (QCPs). Pressure, magnetic field, or chemical substitution are the common parameters to drive a material from one ground state to another and to explore the phase diagram. How a ferromagnetic (FM) state disappears has long been the subject of intense research. There is presently strong evidence that in most materials a quantum phase transition is prevented by the coupling of the FM order parameter to particle hole soft modes, which induces a first order transition or other types of magnetic order before the Curie temperature, T_C, reaches T=0. Therefore, the recent observation of FM quantum criticality in the new heavy-fermion material $YbNi_4P_2$ substituted with As was remarkable [1].

In this presentation, I review the crystal growth and the thermodynamic characterization of $YbNi_4P_2$ which is a stoichiopmetric FM-Kondo lattice with a severely reduced Curie temperature (T_C=0.17 K) due to strong Kondo screening (T_K~8 K) already very close to the FM QCP [2]. The crystal structure of $YbNi_4P_2$ is novel among heavy-fermion systems with quasi-one-dimensional Yb-chains along the *c*-axis of the tetragonal unit cell. Substituting larger As for P tunes the system towards the FM quantum critical point. The FM transition stays second order and ferromagnetic down to T_C=30 mK, which is the lowest ferromagnetic transition temperature ever observed. The unexpected power-law exponents in all thermodynamic quantities indicate the presence of strong FM quantum critical fluctuations and require new theoretical concepts to describe this FM QCP.

In addition, I present further cases, where correlated metals have been tuned across the FM QCP, extending our understanding of ferromagnetic quantum criticality in general [4].

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