YFe_2Al_{10}: a New Fe-based Quantum Critical System

M. Aronson[a], L. Wu[a], K. Park[b], Y. Janssen[a], M. Kim[a], and C. Marques[a]

[a]Stony Brook University, Stony Brook NY 11794, USA
[b]Brookhaven National Laboratory, Upton, New York 11973, USA

It is increasingly evident that quantum critical points (QCPs) where magnetic order is suppressed to T=0 play a central role in the phase diagrams of most classes of strongly correlated electron materials. Novel critical phenomena are found near QCPS, and when coupled to the electronic structure result in novel metallic states, whose instabilities include unconventional superconductivity. Despite current interest in Fe-based compounds, most detailed information about QCPS comes from experiments on f-electron based heavy fermion compounds. We present here measurements of the magnetization M, ac susceptibility $\chi^{'}$, and specific heat C in metallic YFe_2Al_{10}, where there is no indication of magnetic order above 0.05 K. In zero field, power law divergences are observed for $C/T \propto T^{-0.4}$ and $\chi^{'} \propto T^{-1.26}$, suggesting that YFe_2Al_{10} lies close to a T=0 magnetic phase transition. Magnetic fields suppress these quantum critical fluctuations, leading to scaling behavior with $M(H,T)=T^{-\beta}\mathcal{F}(H/T^{\gamma+\beta})$ and the suppression of the $T \rightarrow 0$ divergence in $\chi^{'}$. A Fermi liquid regime emerges in field for $T \leq T_{FL}(H)$, where the quasiparticles are strongly interacting, and the Sommerfeld coefficient $C/T=\gamma(H) \sim H^{-1/2}$, indicating that their masses are enhanced by $\approx$10 for H=1 T, and even more near the H=0 quantum critical point. Our experiments establish that YFe_2Al_{10} can be considered a d-electron relative of the heavy fermion compounds. [1]

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