MAGNETIC FIELD-TUNED QUANTUM CRITICAL POINT IN CeAuSb$_2$

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Introduction

When the long-range order in a system is suppressed to zero temperature by tuning an external variable, such as pressure, chemical composition or magnetic field $H$, the system is said to exhibit a quantum critical point (QCP) [1]. The magnetic field is an ideal control parameter, since it can be reversibly and continuously tuned towards the QCP. Two compounds with field-tuned QCP, YbRh$_2$Si$_2$ and Sr$_3$Ru$_2$O$_7$, reached prominence due to the non-Fermi liquid (NFL) behavior triggered by the quantum fluctuations associated with the QCP. In this letter we present a Ce-compound, CeAuSb$_2$, exhibiting a field-tuned QCP and unusual transport and thermodynamic properties. All three systems have a field-tuned QCP as a common thread, yet their behavior in high fields and low $T$ are considerably different.

Experimental

Here we report on the anomalous metallic properties of CeAuSb$_2$ having used a combination of cryogenic and high field facilities provided by the NHMFL.

Results and Discussion

$H = 0$, CeAuSb$_2$ displays AF ordering at $T_N = 6.0$ K. Above $T_N$, the resistivity $\rho$ displays a $T^\alpha$ dependence with $\alpha < 1$ and $C_e/T$ has the $-\ln T$ dependence characteristic of NFL behavior. For $T < T_N$, $\rho$ has the $A T^2$ FL-like dependence and the extrapolation of $C_e/T$ to $T = 0$ yields a Sommerfeld coefficient of $\gamma \sim 0.1$ J/mol.K$^2$, so that CeAuSb$_2$ is to be considered a heavy-Fermion system. A magnetic field along the inter-plane direction leads to two subsequent metamagnetic transitions and the concomitant continuous suppression of $T_N$ to $T = 0$ at $H_C = 5.3 \pm 0.2$ T. As the AF phase boundary is approached from the paramagnetic (PM) phase, $\gamma$ is enhanced and the $A$ coefficient of the resistivity diverges as $H - H_C$ [1]. As $T$ is lowered for $H \sim H_C$, the $T$-dependence of $\rho$ and $C_e/T$ is sub-linear and $-\ln T$, respectively. These observations suggest the existence of a field-induced QCP at $H_C$. At higher fields an unconventional $T^3$-dependence emerges and becomes more prominent as $H$ increases, suggesting that the FL state is not recovered for $H >> H_C$.

Conclusions

The field-tuned QCP systems represent a challenge from the theoretical perspective, since the different compounds have some common aspects, but do not seem to belong to the same universality class.

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References