Low Temperature Specific Heat of New Heavy Fermion Materials *and* of Micro-Particles of $Ce(Ru_{0.4}Rh_{0.6})_2Si_2$

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Introduction

We have measured the specific heat down to 0.06 K in zero and applied magnetic field of several newly discovered heavy Fermion systems, including $U_3Ni_5Al_{19}$[1] and $U_2Au_xZn_{17-x}$. Also, the magnetic phase diagram of $Ce(Ru_{1-x}Rh_x)_2Si_2$ contains long range, local moment antiferromagnetism, T_N = 36 K, in pure $CeRh_2Si_2$ which is suppressed with Ru-doping to T=0 at x ≈ 0.6. There is believed to be a quantum critical point ('QCP') at x=0.6. Since the spatial extent of magnetic fluctuations at a QCP should be infinite, we have begun research to measure, in this phase diagram, the low temperature specific heat and magnetic susceptibility of ground powders of varying, rather limited, ranges of size (e. g. 5-10 μ) to investigate the effect of damage/surfaces on the behavior both at, and away from, the QCP concentration.

Experimental

Using SCM-1 at NHMFL, Tallahassee, measurements were made on the specific heat, C, down to 0.05 K in fields ≤ 18 T using the specific heat apparatus of Takano/Andraka. Samples were 2-10 mg in size.

Results and Discussion

Results[2] for the specific heat of $U_3Ni_5Al_{19}$ are shown in Fig. 1. Several of the other heavy Fermion systems measured showed saturation/ordering behavior in C/T at low temperatures. The work on the small particles of $Ce(Ru_{1-x}Rh_x)_2Si_2$ is ongoing.

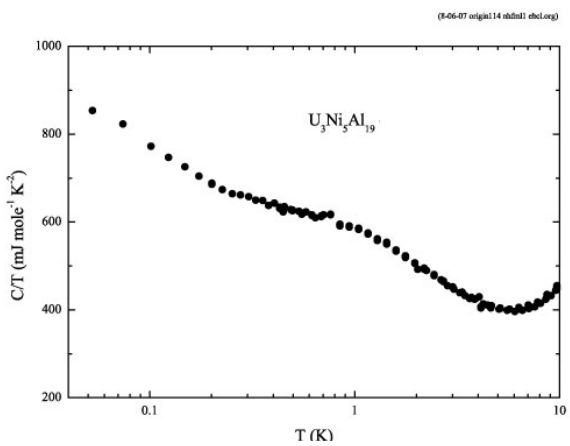

Fig.1 Low temperature specific heat of $U_3Ni_5Al_{19}$ (sample from Eric Bauer). Note the structure in C/T around 1 K.

Conclusions

Specific heat data at dilution refrigerator temperatures continues to reveal fundamental insights into the nature of highly correlated systems. Initial results on small particles of $Ce(Ru_{1-x}Rh_x)_2Si_2$ at the QCP concentration x=0.6 indicate extraordinary enhancements of C/T below 1 K that are monotonically increasing with decreasing size. The results below 0.3 K in 0 and applied magnetic field may (work is ongoing) be consistent with Kondo behavior.

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References

[1] Bauer, E. D., *et al.*, Phys. Rev. B **71**, 014419 (2005).
[2] Kim, J. S., *et al.*, to be submitted to Phys. Rev. B.