SPECIFIC HEAT OF $CeRh_{1-x}Co_xIn_5$ IN HIGH MAGNETIC FIELDS

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Introduction

The $CeMIn_5$ (M = Rh, Co, Ir) family of heavy-fermion compounds exhibit a variety of ground states including superconductivity, antiferromagnetism, the coexistence of both, and a hotly contested Fulde-Ferrel-Larkin-Ovchinnikov (FFLO) state near the upper critical field of $CeCoIn_5$. These ground states can be tuned as a function of magnetic field, concentration, and pressure. Here we investigate the series $CeRh_{1-x}Co_xIn_5$, which exhibits a crossover from superconductivity for the end-compound $CeCoIn_5$ to antiferromagnetism for $CeRhIn_5$ [1]. Both ground states appear to coexist for $0.4 \leq x \leq 0.8$, and a quantum critical point occurs near x = 0.8 where the Néel temperature is suppressed to zero (see figure). The nature of the quantum critical point and how the superconductivity and antiferromagnetism coexist is an open question. Here we investigate the $CeRh_{1-x}Co_xIn_5$ series at high magnetic fields up to 20 T and temperatures down to 60 mK using specific heat and magnetocaloric effect measurements. We seek to determine the evolution of the upper critical field as a function of concentration and to understand the nature of the quantum critical point.

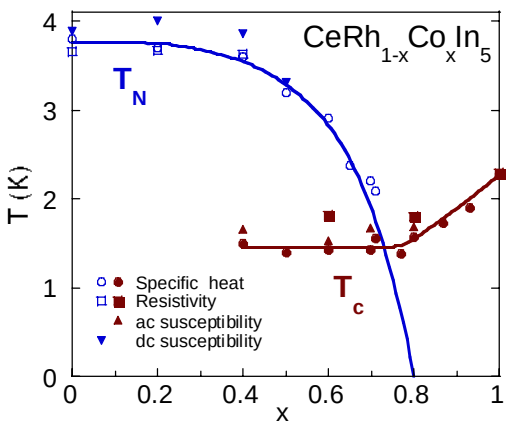

Fig. 1. Temperature-concentration phase diagram of CeRh1-xCoxIn5 showing the Néel temperature T_N and the critical temperature for superconductivity T_c. [1]

Experimental

Initial attempts to measure the specific heat of single crystals of $CeRh_{1-x}Co_xIn_5$ in the dilution refrigerator of the 20 T magnet at NHMFL-LANL have revealed that the samples suffer from a poor thermal contact to the sapphire plate of our calorimeter. This and the loss of our field-calibrated thermometer require us to rebuild and recalibrate our calorimeter. We have completed calibration of a new ruthenium oxide thermometer in fields up to 18 T and temperatures down to 40 mK. We are currently in the process of solving the problem of the thermal contact. Similar problems with poor thermal contact have been found for $CeIn_3$ using both sapphire and silicon calorimeters, and both Apeizon N grease and GE Varnish to attach the sample. We will therefore approach this problem by lengthening the thermal time constant of our calorimeter so it is orders of magnitude longer than the time constant between the sample and the calorimeter. This requires replacing the resistive wires to the heater and thermometer. This work is currently in progress.

References

[1] V. S. Zapf, E. J. Freeman, E. D. Bauer, J. Petricka, C. Sirvent, N. A. Frederick, R. P. Dickey, and M. B. Maple, Phys. Rev. B **65**, 014506 (2001).