Pulsed Field Calibration of Thermometers for Heat Capacity Measurements

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Introduction

The experiments for 2014 focused on the field dependence of the absolute values of the low temperature heat capacity in the cuprate superconductors known as YBCO ($YBa_2Cu_3O_{6+\delta}$) and $La_{2-x}Sr_xCuO_4$. The goal was to explore the effect of field on the low lying electronic excitations of the superconducting state. High precision measurements require sensitive thermometers that are well-calibrated for temperature measurement in high magnetic fields (H). Isothermal measurement in pulsed magnetic fields allows the characterization of a resistance thermometer with temperature and magnetic field as orthogonal variables.

Experimental

All experiments took place at the PFF facility at Los Alamos National Laboratory in the 65 tesla Short Pulse magnet. The primary enemy of any thermometry calibration is uncharacterized temperature drift. The thermometer was successfully held isothermally during pulses up to 47 T for temperatures from 1 kelvin to 12 K. The random noise was significantly lower than the thermometer's intrinsic magnetoresistive effects, producing substantial improvements over a thermometer calibrated solely in zero magnetic field.

Results and Discussion

The resulting data was of high quality and useful for high precision heat capacity measurements.

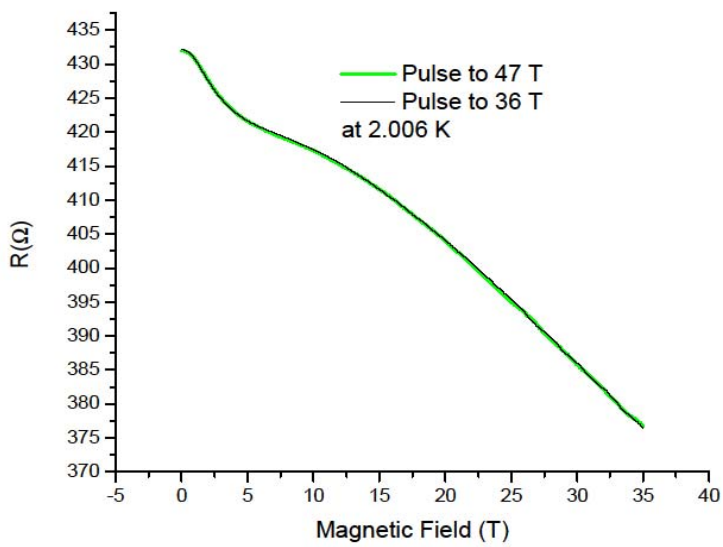

Figure 1 Magnetoresistance of the thermometer at K from the decreasing H part of pulses to 36 T and 47 T (truncated). The high repeatability implies strongly that no systematic nor random heating occurred.

Conclusions

The results of the heat capacity study are currently being written into a manuscript for peer-reviewed publication on cuprate superconductors commonly referred to as LSCO and YBCO.

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