The Influence of Magnetic Field on Cu(tn)Cl\textsubscript{2} - Two-dimensional Quantum Magnet with a Néel Ground State


Introduction

Two-dimensional quantum magnets have attracted attention due to their unconventional magnetic properties resulting from the interplay between quantum fluctuations and geometrical frustration. Previously, we identified Cu(tn)Cl\textsubscript{2} as a two-dimensional, $S = 1/2$ magnetic system with intralayer exchange coupling of $J/k_B \approx -3$ K, interlayer coupling $J' \approx 10^{-3} J$, and no phase transition down to 60 mK in zero applied magnetic field [1]. Subsequently, specific heat studies performed in magnetic fields up to 14 T revealed the presence of an anomaly, which was mapped on to a phase diagram extending down to nominally 350 mK and up to 7 T [2]. These data suggest the formation of a field induced Berezinski-Kosterlitz-Thouless (BKT) transition theoretically predicted for two-dimensional magnet with a Néel ground state [3].

Experimental

The low temperature, high magnetic field measurements were made using the newly installed Oxford dilution refrigerator equipped with a 10 T superconducting magnet, and this instrument is part of the NHMFL High-B/T Facilities housed in Williamson Hall, which is adjacent to the Microkelvin Research Laboratory, at the University of Florida in Gainesville. The AC (typically 232 Hz) magnetic susceptibility was measured by a primary coil wound from monofilament, Cu-clad NbTi wire and two, counterwound secondary coils made with Cu wire. The isothermal magnetic response was measured from 40 mK to 1 K in typical steps of 100 mK, while sweeping the magnetic field up to and down from 10 T at a rate of ~ 0.1 T/min, and additional traces were taken near 4 K for comparison to DC data acquired with a commercial SQUID magnetometer. The sample, consisting of a random arrangement of microcrystalline powder, was bathed in a reservoir of pure $^3$He, which was thermally anchored to the mixing chamber of the dilution refrigerator.

Results and Discussion

From the scientific perspective, although the analysis is not yet complete, since the data were acquired in November 2008, the results have confirmed and extended the magnetic phase diagram of Cu(tn)Cl\textsubscript{2}, which may possess a magnetic field induced BKT phase at low temperature. From the technical perspective, the measurements provide important insight into the ranges of sensitivity, temperature, and magnetic field that users may employ when designing experiments for this facility.

Conclusions

Presently, these results are being combined with theoretical studies and neutron scattering investigations in an attempt to elucidate the nature of the low temperature, high magnetic field phase. Furthermore, extensions of the measuring techniques are being considered to allow operation over a wider range of frequency.

Acknowledgements

Work supported by MVTS-NSF/UPJS-08, VEGA 1/3027/06, NSF DMR-0701400 (MWM), and the NHMFL via cooperative agreement NSF DMR-0654118 and the State of Florida.

References