Observation of a Bose Glass State in Doped Quantum Magnet

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Introduction

Dichloro-tetrakis-thiourea-nickel (DTN) consists of S=1 Ni^{2+} ions oriented along the c-axis and coupled in the a-b plane. The ground state is equivalent to that of a Mott insulator of bosons with each spin close to the $|m_s=0>$ state separated by an energy gap of about 3.8K from the excited spin states. The application of a magnetic field of 2.1 T can close the gap leading to a Bose-Einstein condensation of the bosonic states. At much higher magnetic fields H ~ 12.2 T the spins become saturated and the system transits from a BEC to a Mott insulator. This is a particularly clean system for exploring the effect of disorder on the BEC transition because the Cl atoms can be readily replaced by Br thereby modifying the magnetic interactions. In this study the magnetization was measured for a single crystal sample with 8% Br substitution.

Experimental

The magnetic susceptibility of the doped DTN sample was measured at the NHMFL High B/T Facility as a function of temperature down to 1 mK and applied fields up to 15 T, using a high sensitivity magnetic susceptometer [1]. The temperatures were obtained using a PrNi5 nuclear demagnetization refrigerator. Thermal contact to the sample was secured by immersing the sample in a bath of liquid ^{3}He.

Results and Discussion

The observed field dependence of the ac magnetic susceptibility is shown in **Figure 1** [2]. In contrast to the results for pure DTN [3] for which a single sharp transition is observed, a double transition is observed. This behavior is expected for a transition from the macroscopic BEC phase to a Bose glass state, followed by a transition to a Mott insulator.

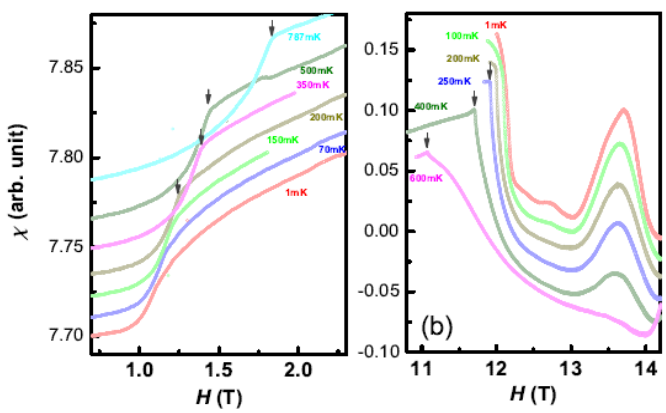

Figure 1. Field dependence of the ac magnetic susceptibility for Br-doped DTN at (i) the lower critical filed and (ii) the upper critical field. Clear evidence of a Bose glass state is seen for 12.2<H<13.5 T.

Conclusions

High sensitivity measurements of the magnetic susceptibility of a doped quantum magnet show the formation of regions of a Bose glass state on either side of the BEC phase for Br substituted dichloro-tetrakis-thiourea-nickel.

References

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[3] Yin, L. *et al.*; Phys. Rev. Lett. **101**,187205 (2008).