Magnetic-Field-Induced Quantum Criticality of the Spin-1/2 Two-Leg Spin-Ladder Compound IPA-$CuCl_3$

H. Tsujii (Kanazawa Univ., Physics); Y. Yoshida, Y. Kim, Y. Takano (UF, Physics); T.P. Murphy (NHMFL); K. Kanada, T. Saito, A. Oosawa, T. Goto (Sophia Univ., Physics)

Introduction

In IPA-$CuCl_3$, the S=1/2 Cu^{2+} spins form two-leg ladders in which the rungs represent stronger, ferromagnetic bonds and the legs represent weaker, antiferromagnetic bonds [1]. These ladders are weakly coupled with each other via weak antiferromagnetic interactions. The evolution of the magnetrism of such spin ladders in magnetic field is similar to that of weakly coupled Haldane chains: quantum-mechanically disordered spin liquid turning into a three-dimensionally ordered state, which can be described as a Bose-Einstein condensate of magnons, at a critical field H_c. At this quantum critical point, the magnons, which are gapped in the spin liquid, becomes gapless. To validate the Bose-Einstein-condensation interpretation of the magnetic-field-induced ordering in IPA-$CuCl_3$, however, the temperature dependence of the boundary between the spin-liquid phase and the ordered phase has to be carefully measured and its critical exponent must be extracted.

Experimental

We have measured the magnetic torque to determine the boundary between these two phases near the quantum critical point $H_c \approx 10$ T. The measurements were made in a superconducting magnet at the NHMFL DC-Field Facility, primarily at temperatures below 0.4 K, the region in which the magnetocaloric effect is an inaccurate tool as it becomes dominated by the uninteresting nuclear contributions from hydrogen and copper. Two crystal orientations were studied: the first with the so-called A plane perpendicular to the magnetic field H and the second with the so-called B plane perpendicular to H. Data analysis has not yet been completed.

Acknowledgement

This work was supported by a Grant-in-Aid from the JSPJ.

Reference

[1] Masuda, T., *et al*., Phys. Rev. Lett. **96**, 047210 (2006).