FIELD DEPENDENT PHASE DIAGRAM AND LOW TEMPERATURE MAGNETIC SUSCEPTIBILITY OF FERROMAGNETIC – ANTIFERROMAGNETIC ALTERNATING QUANTUM SPIN CHAIN: (CH$_3$)$_2$NH$_2$CUCL$_3$

M.B. Stone (Condensed Matter Sciences Division (CMSD), Oak Ridge National Laboratory); W. Tian (The University of Tennessee, Physics); S.E. Nagler, D.G. Mandrus (CMSD, ORNL)

Introduction

(CH$_3$)$_2$NH$_2$CuCl$_3$ or DMACuCl$_3$ has been suggested to be a quasi-one dimensional S=1/2 quantum spin chain with similar magnitude of ferromagnetic and antiferromagnetic exchange interactions [1]. Such a system should show competing behavior between spin-1/2 (AFM) and spin-1(FM) effects and also profound effects as a function of applied magnetic field. It is of particular interest to study the temperature and field dependent phase diagram and thermodynamic properties of DMACuCl$_3$.

Experimental

The low temperature AC susceptibility and capacitive torque magnetometry measurements down to 0.25 K with the applied magnetic field parallel to the proposed chain axis $a$-axis were performed using the 18 T superconducting magnet at NHMFL employing a split coil susceptometer and cantilever magnetometer, respectively.

Results and Discussion

The field dependent AC susceptibility measured at T = 0.25, 0.53, and 1.05 K are shown in Fig. 1 (left). Three anomalies were observed consistent with the capacitive torque magnetometry measurements. They indicate that DMACuCl$_3$ is in a potential magnetic ordered phase below 0.8 K and between 0 T to 0.5 T. DMACuCl$_3$ undergoes a low field phase transition at approximately 2 T and the saturation field is about 14 T. Fig. 2 (right) depicts the derived phase diagram. A very unusual second magnetic field induced ordered phase is observed. This intermediate field phase transition may be attributed to the coexistence of FM and AFM interactions in DMACuCl$_3$.

Conclusions

Field dependent AC susceptibility and capacitive torque magnetometry were measured at different temperatures. A likely long range order transition is observed at 0.8 K. A very unusual phase diagram is derived. It indicates that DMACuCl$_3$ consists of a low temperature, low field long range ordered phase, a very unusual second magnetic field induced ordered phase and a ferromagnetic polarized phase above 14 T [2].

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References