HIGH FIELD PHASE DIAGRAM OF M$_3$CrO$_8$ COMPOUNDS: EXPLORING THE POSSIBILITY OF NEW S=1/2 BOSE-EINSTEIN SYSTEMS

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Introduction

Recently, there has been renewed interest in the search for new model quantum spin systems that can exhibit BEC of magnons [1,2]. Chromium in peroxychromates (M$_3$CrO$_8$, M = Na$^+$, K$^+$, Rb$^+$, Cs$^+$) is in a rare oxidation state of 5+ and is coordinated to four peroxy ligands, (O$_2$)$_2^-$, in a dodecahedral geometry. These compounds are not only the simplest spin system available ($S = \frac{1}{2}$, $I = 0$) but also have the advantage that they can be grown as large single crystals [3]. Due to its low-dimensionality of a spin network and peculiar oxidation state, M$_3$CrO$_8$ is a promising candidate for a study of BEC.

Experimental

The superconducting magnet (SCM2) equipped with a $^3$He insert (250 mK – 70 K) and a sample rotator at the National High Magnetic Field Laboratory was used to collect torque data of K$_2$NaCrO$_8$ single crystal.

Results and Discussion

A representative example of torque spectrum of K$_2$NaCrO$_8$ at 280 mK is shown in Figure 1. Neither angular dependence nor hysteresis was observed for this compound. Figure 2 shows the $B$ vs $T$ phase diagram. The zero-field transition temperature is obtained from the specific heat measurements. The fact that the transition temperature is strongly suppressed around a saturation field of ~7.3 T and that there is no indication for a hysteresis behavior implies the possibility of a quantum phase transition. Specific heat measurements at dilution fridge temperatures are planned in the near future to follow the transition temperature toward 0 K around 7.3 T. This will enable us to extract the critical exponent ($\alpha$) from the relation $k_B T_c \sim (B_c-B)^\alpha$ and to clarify whether BEC of magnons is realized in our Chromate material.

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References