Multiple Magnetic Transitions in the Quasi-One Dimensional Heisenberg Magnet $NaVPO_5$

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Introduction

$NaVPO_5$ crystallizes in the monoclinic $P2_{1/c}$ crystal structure and can be modeled as a quasi-one-dimensional spin ½ alternating Heisenberg chain [1] with antiferromagnetic (AFM) coupling *J* of the order of 32 K [2]. Ab initio band-structure calculations predict AFM and ferromagnetic interchain interactions between 5 and 10 K that lead to frustration in the system [2]. Zero field measurements of the specific heat exhibit a phase transition at 6 K. This presumably AFM order is quite robust against the application of a magnetic field and shifts by only -0.5 K in 9 T. A second transition around 1 K can be observed in small magnetic fields that moves to 1.8 K in 9 T. To date, the exact magnetic structure of $NaVPO_5$ is unknown and a topic of vivid ongoing investigations.

Experimental

We measured magnetization at the NHMFL, LANL Los Alamos in one of the capacitor-driven short pulse magnets up to 62 T and in the temperature range between 4 K and 0.36 K. The experiments were carried out with the compensated pick-up coil technique on high quality polycrystalline samples.

Results and Discussion

Fig. 1 shows the magnetization versus field for different temperatures. We observe a linear response of the magnetization between 0 T and 45 T followed by an increase at about 50 T for all three measured temperatures, 4 K, 1.5 K and 0.36 K. The magnetization saturates for fields exceeding 56 T. This effect is more pronounced for temperatures below 4 K.

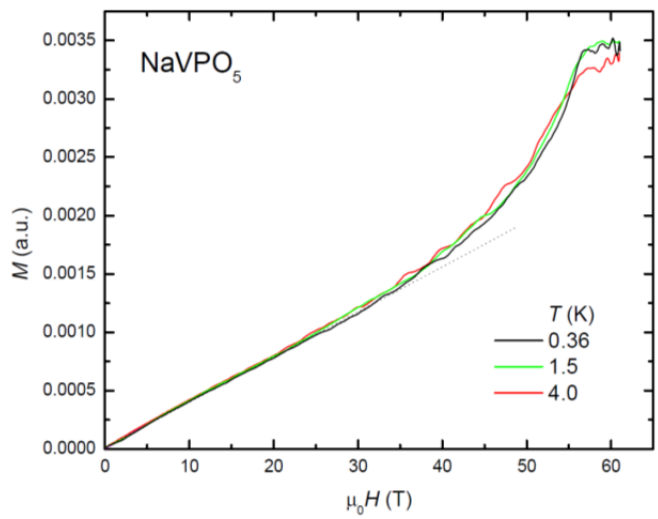

Figure 1. Magnetization of $NaVPO_5$ up to 62 T measured between 4.0 and 0.36 K.

Conclusions

The behavior of the magnetization down to 0.36 K indicates that the presumably AFM order in $NaVPO_5$ is suppressed continuously by the smooth alignment of the magnetic moments with a magnetic field. No abrupt change of the spin structure reflected in a step or jump in the magnetization is observed. Fig. 2 summarizes the experimental results in the *T*-*H* phase diagram.

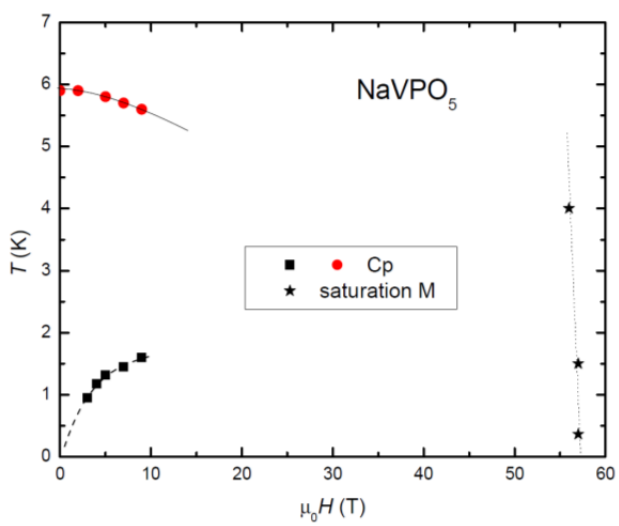

Figure 2. *T* - *H* phase diagram of $NaVPO_5$. Squared and round symbols mark anomalies in the specific heat measurement. Stars label the onset of saturation in the magnetization.

Acknowledgements

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References

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[2] Tsirlin, A. A. *et al*., unpublished results (2013).