Double Magnetic Field-Induced Phase Transition in the Spin ½ Alternating Chain System $AgVOAsO_4$

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Introduction

$AgVOAsO_4$ consists of a network of spin ½ alternating chains with dominant antiferromagnetic (AFM) exchange interactions. The crossing chains are connected in the 2nd and 3rd dimensions via AFM and ferromagnetic (FM) couplings that cause frustration and lead to the opening of a spin gap at low temperatures [1]. The spin gap of 13 K in zero field can be closed via the Zeeman effect by applying a magnetic field H_{c1} of 10 T. Interestingly, two distinct anomalies occur in specific heat measurements above H_{c1} suggesting the formation of magnetic field-induced order [2]. The nature of this order is currently discussed in the context of Bose-Einstein-condensation (BEC) of magnons.

Experimental

We measured magnetization at the NHMFL, Los Alamos in a capacitor-driven short pulse magnet up to 58 T between 10 K and 0.64 K. The experiments were carried out with the compensated pick-up coil technique on polycrystalline samples.

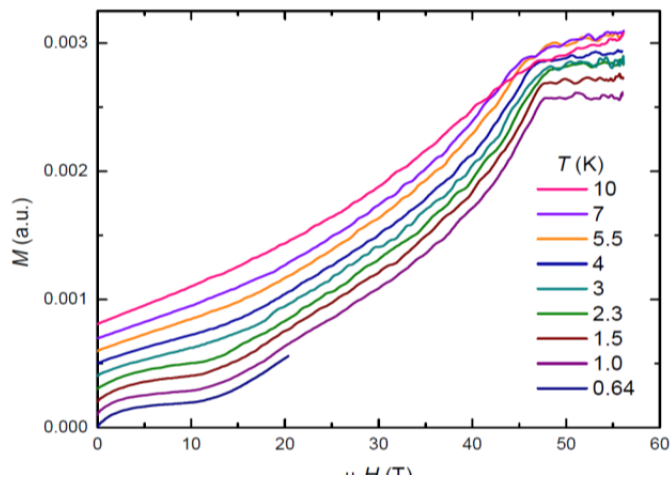

Fig. 1. Magnetization vs. magnetic field of $AgVOASO_4$. The curves are shifted by +1E-4 for better visibility.

Results and Discussion

Fig. 1 shows the magnetization of $AgVOAsO_4$ versus magnetic field for different temperatures. At low fields $H < H_{c1}$, the magnetization is dominated by paramagnetic impurities with Brillouin-function behavior. The intrinsic magnetization of $AgVOAsO_4$ is zero due to the spin singlet state $S = 0$. At H_{c1}, the magnetic spin gap closes and the low lying energy level of the $S = 1$ triplon state starts to be populated leading to a finite increasing magnetization. The magnetization saturates for fields exceeding $H_{c2} = 48$ T where all spins are fully polarized. The observed kink of M at H_{c1} and the saturation of M at H_{c2} are more pronounced at lower temperatures.

Conclusions

Fig. 2 summarizes the observed anomalies in the magnetization and compares them with previous results of the specific heat in the H-T phase diagram. The critical fields H_{c1} and H_{c2} are temperature independent as expected. For $T \rightarrow 0$, the lower phase boundary estimated by specific heat measurements coincides with H_{c1}. At higher temperatures, the anomalies in $M(H)$ and $C_p(H)$ are decoupled.

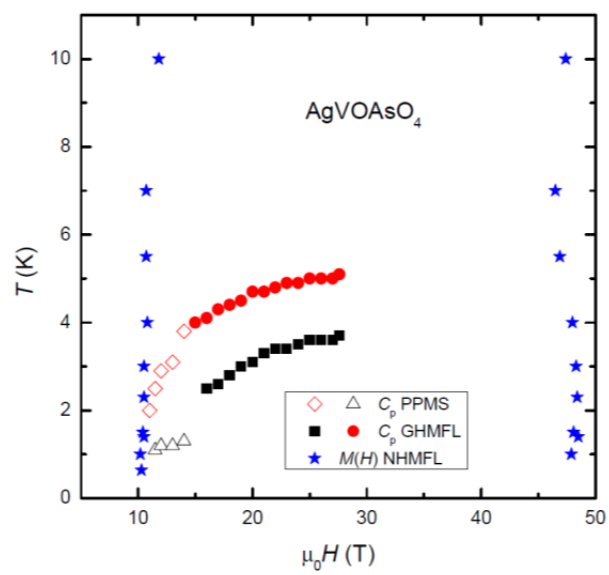

Fig. 2. Magnetic phase diagram of AgVOAsO4. Specific heat data are unpublished results [2].

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References

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[2] Weickert, F. *et al*, unpublished results (2013).