MAGNETIZATION OF K$_2$V$_3$O$_8$ UNDER HIGH MAGNETIC FIELDS

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K$_2$V$_3$O$_8$ is an $S=1/2$ quasi-two-dimensional Heisenberg antiferromagnet, with Neel ordering at $T_N = 4$ K. It undergoes unusual field-induced spin reorientations (spin flop for $H//c$ and spin orientation for $H\perp c$) due to the interplay between Dzyaloshinskii-Moriya interactions and easy-axis anisotropy [1]. Recently, two large magneto-optical effects, centered at 1.19 and 2.50 eV have been observed [2]. These are attributed to magnetic field – induced changes in the V$^{4+} d \rightarrow d$ on-site excitations due to modification of the local crystal field environment of VO$_5$ square pyramids with applied magnetic field [2].

The issue is whether such a modification affects both electronic and magnetic properties as V$^{4+}$ ions have spins with $S=1/2$.

For probing possible electronic property change, we attempted to measure the electrical resistance of K$_2$V$_3$O$_8$. Unfortunately, the system remains insulating down to 0.3 K by applying magnetic field up to 33 tesla (using facilities located in cell 7 at NHMFL). On the other hand, high field magnetization studies were carried out using a vibrating sample magnetometry technique for $H//c$ and $H//ab$ (the magnet in cell 7).

Shown in Figure 1 is the magnetization of K$_2$V$_3$O$_8$ as a function of applied magnetic field ($H//c$) at 1.6 K (solid line) and 20 K (dashed line). The inset is the magnetization for $H//ab$ at 1.6 K. While $M$ varies with $H$ more or less linearly at high temperatures, the slope $dM/dH$ clearly increases above 9 tesla at 1.6 K, with no sign of saturation up to 33 tesla for both $H//c$ and $H//ab$. Apparently, the high magnetic field reduces the antiferromagnetic coupling strength at low temperatures. According to Ref. [3], we estimate the canting angle to be $\sim 29^\circ$ at 33 tesla for $H//c$. Besides the change in slope at 9 tesla, there are no other features in the magnetization that correlate with the optical properties. The results are summarized in Ref. [2].

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References