Tremendous difference in magnetism between the triangular-dimer-lattice antiferromagnets $Rb_2Ni_2(SeO_3)_3$ and $K_2Co_2(SeO_3)_3$

We found the tremendous difference in magnetism between the triangular-dimer-lattice compounds Rb2Ni2(SeO3)3 and K2Co2(SeO3)3 by structure and magnetic characterization, high magnetic field magnetization measurements, as well as density-functional theory calculations.

The newly synthesized $Rb_2Ni_2(SeO_3)_3$ is magnetically ordered at 5.8 K and undergoes two-step antiferromagnetic (AFM) transitions when magnetic field is applied along the easy c axis ($H//c$). The high-field magnetization at 2 K for $H//c$ demonstrates a 1/3 magnetization plateau within 17.6 - 25.1 T, followed by a possible narrow 1/2 plateau within 27.4 - 28.6 T (see Fig. 1). No plateau is observed for $H//ab$. The density functional theory (DFT) calculations reveal that the exchange within the structural dimer (J_0) is significantly smaller than the exchange in the triangular-lattice layer (J_1), which explains why $Rb_2Ni_2(SeO_3)_3$ behaves like an easy-axis triangular lattice antiferromagnet (TLAF).

However, for $K_2Co_2(SeO_3)_3$, which is disordered down to 2 K, the high-field magnetization at 1.6 K shows a 1/3 magnetization plateau within 3.6 - 7.7 T and a 1/2 plateau within 10.1 - 13.0 T for $H//c$, and only a wide 1/3 plateau within 9.1 - 15.5 T for $H//ab$ (see Fig. 2). The DFT calculations reveal that J_0 is much larger than the J_1, in contrast with the Ni compound. Thus, $K_2Co_2(SeO_3)_3$ is a coupled dimer antiferromagnet that combines the characteristics of AFM dimer and TLAF. Two phenomenological models, including AFM singlet dimers in $K_2Co_2(SeO_3)_3$ and ferromagnetic structural dimers in $Rb_2Ni_2(SeO_3)_3$, are proposed to explain the magnetization plateaus along the c axis.

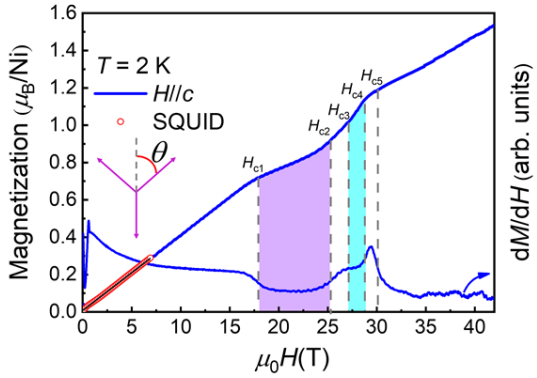

Fig.1 High magnetic field magnetization of $Rb_2Ni_2(SeO_3)_3$

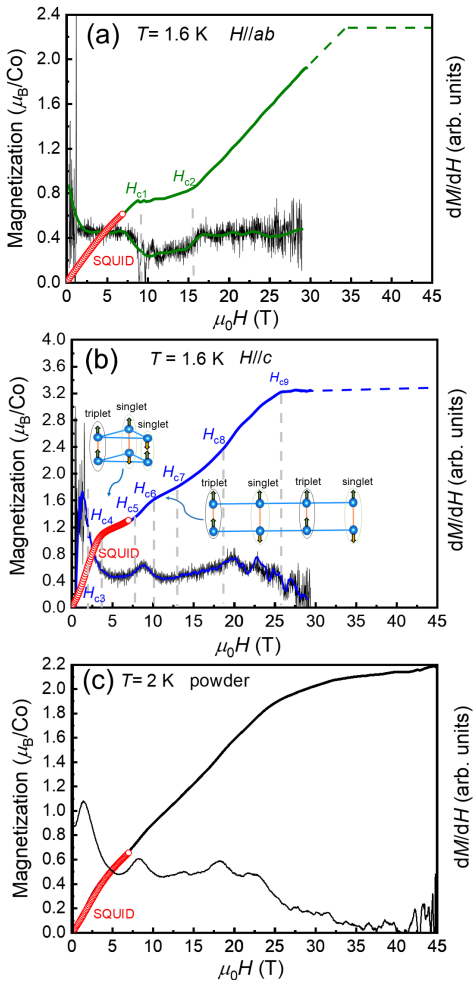

Fig.2 High magnetic field magnetization of $K_2Co_2(SeO_3)_3$

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