ANISOTROPIC PHASE DIAGRAM OF THE FRUSTRATED SPIN CHAIN β-$TeVO_4$.

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Complex many-body problems can be described by theoretical models particularly effective for one-dimensional (1D) spin systems. On the experimental side, many of the three-dimensional (3D) magnetic materials feature well-separated 1D chain that are only weakly linked together in a 3D framework. This combination provides excellent conditions to explore 1D physics and emergent phenomena. However, magnetic frustration renders the problem far more complex even in 1D.

The talk/poster will present experimental as well as theoretical data on β-$TeVO_4$ a candidate for a zigzag S = ½ chain compound. Its magnetic behavior was initially described within the model of a uniform spin chain, although the presence of three low-temperature transitions at $T_{N1} \approx 4.7$ K, $T_{N2} \approx 3.3$ K, and $T_{N3} \approx 2.3$ K observed in susceptibility measurements point to a more complex interaction scheme. Recently, Saul and Radtke [1] performed a microscopic analysis of isotropic exchange couplings and suggested that β-$TeVO_4$ is a good realization of the J_1-J_2 chain model with ferromagnetic $J_1 = -18$ K and antiferrromagnetic $J_2 = 48$ K coupling constants. Neutron diffraction experiments by Pregelj *et al*. [2] observed an incommensurate magnetic structure with propagation vector k =(-0.208, 0, 0.423) below T_{N3}. The neutron scattering results revealed furthermore, the existence of an enigmatic stripe-like spin texture between T_{N2} and T_{N3} and spin-density wave (SDW) ordering between T_{N2} and T_{N1}.

In this work we explore the magnetic phases of β-$TeVO_4$ with measurements of the magnetization, specific heat, magnetostriction, thermal expansion performed on oriented single crystals at temperatures between 500 mK and 50 K and in magnetic fields to 50 T. The high field data were taken in a capacitor bank-driven pulsed magnet at NHMFL – LANL and complemented with measurements in a superconducting magnet below 9 T. Our comprehensive study allows for the first time a detailed mapping of the phase diagram in both directions, H ll ab and H ll c. We find clear evidence for 5 different phases including full polarization of the magnetic moments above 23 T only weakly dependent on the crystal orientation. Surprisingly, the phase boundary of the saturation field splits into two distinct lines below 5 K. The magnetic phases occurring at fields below 10 T show significant magnetic anisotropy between H l lab and H ll c.

The nature of the different phases and regions in β-$TeVO_4$ is still far from being understood, but our results will stimulate further research on this interesting model compound

[1] A. Saul and G. Radtke, PRB **89**, 104414 (2014).
[2] Pregelj, M. *et al*., Nature Comm. **6**, 7255 (2015).
[2] F. Weickert *et al*., *to be published*.

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