ANISOTROPIC PHASE DIAGRAM OF THE FRUSTRATED SPIN CHAIN $\beta$-TeVO$_4$.

F. Weickert$^1$, M. Jaime$^1$, N. Harrison$^1$, B.L. Scott$^2$, A. Leitmae$^3$, I. Heinmaa$^3$, R. Stern$^3$, O. Janson$^{3,4}$, H. Berger$^5$, H. Rosner$^4$, and A. A. Tsirlin$^4$.

$^1$MPA-CMMS, Los Alamos National Laboratory, Los Alamos, New Mexico 87545, USA
$^2$MPA-11, Los Alamos National Laboratory, Los Alamos, NM, USA
$^3$National Institute of Chemical Physics and Biophysics, 12618 Tallinn, Estonia
$^4$Max Planck Institute for Chemical Physics of Solids, 01187 Dresden, Germany
$^5$Ecole Polytechnique Federale de Lausanne, Lausanne 1015, Switzerland

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 $\beta$-TeVO$_4$ a candidate for a zigzag $S = \frac{1}{2}$ 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 $\beta$-TeVO$_4$ is a good realization of the $J_1$-$J_2$ chain model with ferromagnetic $J_1 = -18$ K and antiferromagnetic $J_2 = 48$ 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 $T_{N3}$.

In this work we explore the magnetic phases of $\beta$-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, $H \parallel ab$ and $H \parallel c$. 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 $H \parallel ab$ and $H \parallel c$.

The nature of the different phases and regions in $\beta$-TeVO$_4$ is still far from being understood, but our results will stimulate further research on this interesting model compound.

[2] F. Weickert et al., to be published.

Category: LD
Email: weickert.ph@gmail.com