**High field magnetization in FePS3**

Wildes, A.R. (Institut Laue-Langevin, France); Chan, M.K. (NHMFL, LANL); Weikert, F. (NHMFL, LANL)

**Introduction**

FePS3 is known to be a good example of a quasi-two dimensional Ising antiferomagnet [1]. The Fe atoms form a honeycomb lattice in the *ab* planes. The compound orders magnetically below its Néel temperature of 125 K with a propagation vector of **k** = [0 1 1/2]. The Fe2+ moments point normal to the *ab* planes in this structure, forming ferromagnetic zig-zag chains parallel to the *a* axis that are coupled antiferromagnetically along the *b*-axis.

A two-dimensional Ising system in a transverse field is an archetypical model for quantum phase transitions and tricritical points. A series of the magnetization experiments were performed to search for these in FePS3. Two previous high-field experiments were performed at LANL. The measurements with the field normal to the *ab* planes had been successfully completed, showing two sharp jumps in the magnetization at 4 K and a large hysteresis. The data also showed a remarkable difference between measurements performed at 4 K in gaseous helium, being more adiabatic, and in liquid helium, being isothermal. Measurements with the field in-plane had also been performed, however the field direction was not along one of the high symmetry directions due to a misidentification of the crystal orientation. The orientation had since been unambiguously identified.

The current experiment aimed to finish the in-plane measurements.

**Experimental**

The experiments were performed using the magnetometry probe of Dr. Fraziska Weikart in a 65 Telsa pulsed magnet at LANL on samples with field aligned along either the *a* or *b* axes. The samples were cooled to 4 K and magnetization was measured to 65 T. Temperature-dependent measurements were also performed.

**Results and Discussion**

 **Figure 1:** Representative magnetization data for FePS3 with the field applied along two in-plane directions.

Fig.1 shows preliminary data from the measurements with the field applied along the two different crystallographic directions. The **H** || **a** data, with the field applied parallel to the chains, show no sign of any transition, with the sample showing a constant susceptibility to 65 Tesla. The measurements had no strong effects on the sample. Conversely, the **H** || **b** data, with the field applied perpendicular to the chains, show no transitions to ~55 Tesla. A series of sharp transitions are then seen to the maximum field. The sample then shows a strong hysteresis, with a single strong transition at ~28.5 Tesla, suggesting that the transitions are first-order in nature. Measurements in this orientation were not reproducible, and the recovered sample was seriously damaged.

The data show a high degree of in-plane anisotropy that was not expected. The **a** axis is clearly an easy direction, and a large degree of magnetostriction is associated with the **b** axis. The measurements are now being combined with inelastic neutron scattering and considered with theory to determine the nature of the anisotropy in the compound.

**Conclusions**

The data show sharp features that suggest first-order phase transitions. The magnetic anisotropy in FePS3 cannot be considered as a simple single-ion term in the Hamiltonian. The data are now being analysed to determine the nature of the anisotropy.

**Acknowledgements**

A portion of this work was performed at the National High Magnetic Field Laboratory, which is supported by National Science Foundation Cooperative Agreement No. DMR-1157490 and the State of Florida.

**References**

[1] Lançon, D. *et al*., Phys. Rev. B, **94** 214407-1 - 214407-11 (2016).