



Contribution ID: 47

Type: Talk

Frustrated pyrochlore lattice in FeV_2O_4 under uniaxial pressure

Monday, 11 May 2026 10:30 (20 minutes)

Multiferroics have been at the forefront of condensed-matter research for several decades due to their importance for fundamental understanding of the coupling between magnetic and electric properties, as well as their potential for the development of energy-efficient data storage technologies [1,2]. Magnetic spinels such as iron vanadate, FeV_2O_4 , in which V ions occupy a geometrically frustrated pyrochlore lattice of corner-sharing tetrahedra, form a highly versatile class of systems for studying exotic phenomena such as frustration and/or electron itinerancy.

Synchrotron x-ray scattering studies [3,4] have revealed several structural phase transitions in FeV_2O_4 . Two of these transitions coincide with the onset of long-range magnetic order: a collinear ferrimagnetic phase below $T_{N1}=110\text{K}$ and a non-collinear ferrimagnetic structure below $T_{N2}=60\text{K}$ [5,6], where the V spins adopt a 2-in-2-out configuration. Furthermore, this material is remarkable for the strong effect of applied hydrostatic pressure on both the ferromagnetic coupling and the electrical resistivity [7]. The spin dynamics at ambient pressure were previously investigated on SEQUOIA [8] and HB-3 [9], revealing anomalous spin-wave broadening in the temperature range between T_{N1} and T_{N2} . The sequence of structural, electric, and magnetic transitions in FeV_2O_4 highlights the strong coupling between the crystal lattice and the spin-orbital degrees of freedom of both Fe and V magnetic ions.

One focus of our work is the effect of uniaxial pressure on structure and dynamics of FeV_2O_4 . By deforming the crystal environment, uniaxial strain may lift the magnetic frustration of the pyrochlore lattice. In our first experiment, we monitored the order parameter of the $(111)_c$ magnetic reflection on the EIGER triple-axis spectrometer together with a recently developed in-situ uniaxial pressure device (UPD) [10]. Pressure was applied along $[110]$ crystallographic direction with forces up to 180 N (~ 0.1 GPa). Even under such a modest force load, both magnetic ordering temperatures change –both magnetic ordering temperatures shift: T_{N1} increases while T_{N2} decreases. This behavior indicates that breaking the bond-length symmetry of the pyrochlore tetrahedra suppresses the 2-in-2-out ordering temperature of the V sublattice. These neutron results were confirmed with measurements of the elastocaloric effect on a FeV_2O_4 single crystal along the same direction. In a subsequent neutron experiment on the IN8 triple-axis spectrometer, we observed a narrowing of magnetic excitations near 4.5 meV at $T=80\text{K}$ under an applied force of 70 N (~ 0.07 GPa), together with a significant reduction in intensity and a change in the critical exponent of the $(200)_c$ reflection, which contains a magnetic contribution solely from the V sublattice. Ongoing data analysis, combined with density functional theory (DFT) calculations, aims to further clarify the complex interplay between lattice distortion, frustration, and spin dynamics in this material.

- [1] M. Bibes et al., *Nature Materials* **7**, 425–426 (2008)
- [2] S. Manipatruni et al., *Nature* **565**, (2019):35-42
- [3] Y. Nii et al., *Phys. Rev. B* **86**, 125142 (2012)
- [4] T. Katsufuji et al., *J. Phys. Soc. Jpn.* **77**, 053708 (2008)
- [5] G. J. MacDougall et al., *Phys. Rev. B* **86**, 060414(R) (2012)
- [6] Q. Zhang et al., *Phys. Rev. B* **85**, 054405 (2012)
- [7] A. Kismarhardja et al., *Phys. Rev. Lett.* **106**, 056602 (2011)
- [8] G. J. MacDougall et al., *Phys. Rev. B* **89**, 224404 (2014)
- [9] Q. Zhang et al., *Phys. Rev. B* **89**, 224416 (2014)
- [10] G. Simutis et al., *Rev. Sci. Instrum.* **94**, 013906 (2023)

Author: PÁSZTOROVÁ, Jana (Forschungszentrum Jülich, JCNS)

Co-authors: NIKITIN, Stanislav (PSI - Paul Scherrer Institut); IVANOV, Alexandre (Insitute Laue-Langevin); SIMUTIS, Gediminas (PSI - Paul Scherrer Institut); ARH, Tina (PSI - Paul Scherrer Institut); FORINO, Paola C. (Technical University of Denmark); GATI, Elena (Goethe-Universität Frankfurt); O'NEIL, Caitlin I. (University of St Andrews); OLSEN, Thomas (Technical University of Denmark); SCHNEIDEWIND, Astrid (Forschungszentrum Jülich, JCNS); CHRISTENSEN, Niels B. (Technical University of Denmark); TOFT-PETERSEN, Rasmus (European Spallation Source)

Presenter: PÁSZTOROVÁ, Jana (Forschungszentrum Jülich, JCNS)