ESRF	**Experiment title: High Resolution Synchrotron Diffraction on the Spin Driven Jahn-TellerEffect Candidate Compound $MnSc_2S_4$**	**Experiment number**: HE-2338
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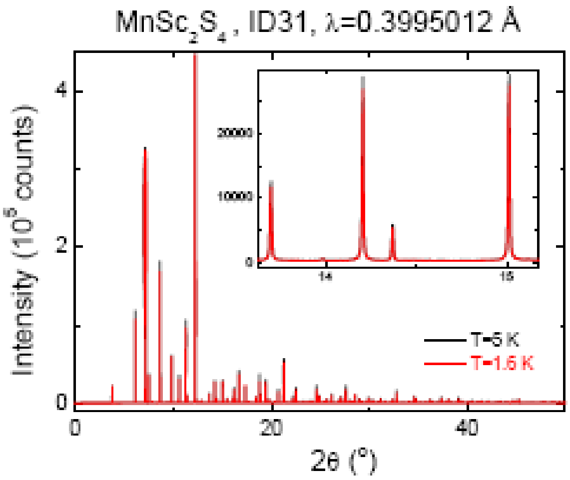
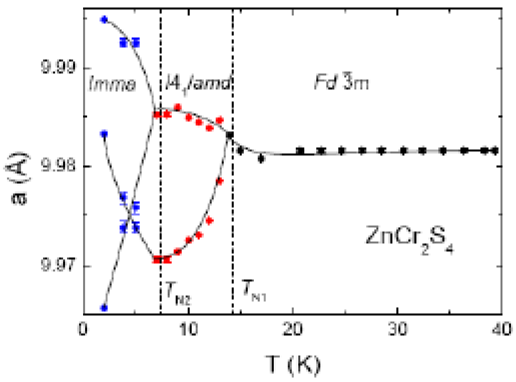
Report: Geometric frustration of spin and orbital degrees of freedom leads to highly degenerate ground states. Orbital degeneracy is usually lifted by a coupling of orbital to lattice degrees of freedom inducing orbital order with a lowering of the crystal symmetry, i.e. the orbital Jahn-Teller effect. The lifting of the spin degeneracy leading to spin order has been discussed in similarly via the spin-driven Jahn-Teller effect [1,2]. This effect may be purely dynamic in nature without involving static lattice distortions. It has been discussed for magnetically frustrated spinel compounds, in particular for Cr based ACr_2X_4 (A=Zn,Cd,Hg, X=O, S, Se) [3,4] and for MSc_2S_4 (M=Mn, Fe) [5,6]. In case of $MnSc_2S_4$, the magnetic spin-only ions Mn^{2+} form a diamond lattice with inherent geometric frustration. A Curie-Weiss temperature Θ_{CW}=-22 K indicated antiferromagnetic (AFM) exchange. However, the compound shows a complex ordering process around 2 K into a non-collinear magnetic structure [6]. This magnetic structure is described by a propagation vector **k**=(0.75, 0.75, 0) indicating 3 spin rotations in a fourfold supercell within the *a*-*b* plane. High resolution neutron powder diffraction experiments gave no indications for any structural changes. However, the anisotropic cycloidic spin structure is incompatible with the cubic *Fd*3*m* symmetry of the spinel structure. We therefore perfomed high-resolution synchrotron powder diffraction experiments on ID31 to look for corresponding lattice distortions. The main experimental difficulty was the low ordering temperature of 2 K. The sample was placed in an aluminum container and mounted in a liquid-helium-cooled cryostat. Measurements could be performed in a temperature range 1.6 K - 40 K. An incident wavelength of λ=0.3995 Å in combination with a large range of the scattering angle $-5.964^{o} < 2\theta < 67.968^{o}$ allowed

measurements up to 17.8 Å^{-1} of the scattering vector Q=4 π sin(θ) /λ. A first indication for the high quality of the sample was given by the observation of sharp Bragg reflections up to the highest available Q-values. However, no difference in the diffraction patterns of $MnSc_2S_4$ at 1.6 K ($T<T_N$) and 5 K ($T> T_N$) could be observed, as illustrated in Fig. 1. There is no peak splitting nor additional superlattice reflection. Even a peak broadening could not be detected. This zero result strongly points to a symmetry breaking on a local scale only.
We therefore decided to continue the measurements on $ZnCr_2S_4$, a further magnetically frustrated spinel compound with strong spin-lattice coupling, as mentioned above. $ZnCr_2S_4$ shows two first order magnetic phase transitions at T_{N1}=15 K and T_{N2}=8 K. Both magnetic phase transitions are accompanied by structural distortions evidenced by a corresponding peak splitting in the diffractograms. The resulting phase diagram is shown in Fig. 2 where the temperature dependent lattice constant (referred to the cubic one) is shown. At T_{N1}, a cubic to tetragonal phase transition takes place, followed by a further transition from tetragonal to orthorhombic symmetry. These results, combined with high resoltution neutron powder diffraction studies, are currently being published [7].



X-ray powder diffraction pattern of $MnSc_2S_4$ at T=1.6 K (red line) and T=5 K (black line). No difference could be observed.



Temperature dependent normalised lattice constant of $ZnCr_2S_4$. The magnetic Transition temperatures and the space groups of the different structures are indicated. The solid lines are to guide the eye

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