# Experimental report

13/11/2018

**Proposal:** 5-42-475 **Council:** 4/2018

**Title:** Small angle neutron scattering studies of the Kagome spinels Co5-xZnxTeO8

**Research area:** Physics

**This proposal is a new proposal**


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**Experimental team:** Alain PAUTRAT

**Local contacts:** Robert CUBITT


**Samples:** Co4ZnTeO8
Co5TeO8 (disordered spinel)
Co3Zn2TeO8
Co5TeO8 (ordered spinel)

| Instrument | Requested days | Allocated days | From | To |
|---|---|---|---|---|
| D33 | 5 | 2 | 01/10/2018 | 03/10/2018 |


**Abstract:**

We have synthetised and started to analysied the stuctural and magnetic properties of the non centro symmetric kagome spinels Co5-xZnxTeO8, where interesting magnetic and magnetoelectric properties are expected. From first neutron scattering and magnetization measurements, we report a complex phase diagram with ferrimagnetic long range order, spiral states and magnetic short range order (including pure spin glasses). Magnetic Small Angle Neutron scattering will be a precious tool for investigated the large scale magnetic structures and the genuine nature of short range ordered states.

**Experiment 5-42-475**

**Small angle neutron scattering studies of the Kagome spinels Co5-xZnxTeO8**

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## Introduction

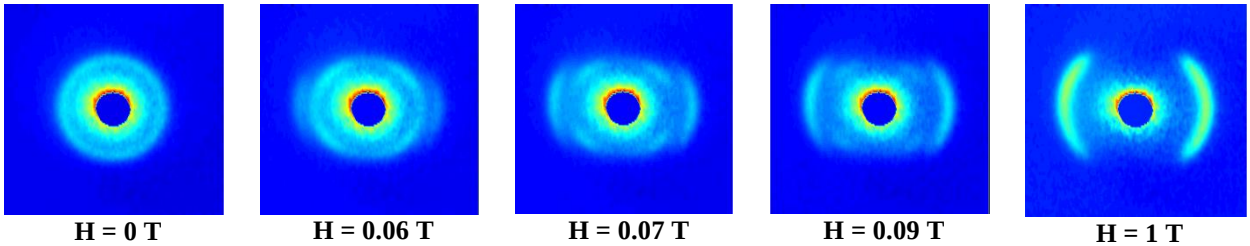
$Co_5TeO_8$ compound has a spinel structure and could be synthesized in two polymorphs: a classical *Fd-3m* and an ordered $P4_332$. An ordered polymorph has two magnetic phase transition to incommensurate conical at 45 K followed by emergence of collinear ferrimagnetic component at 27 K. Moreover magnetic ordering is preceded by formation of short-range spin correlations. It's also possible to obtain $Co_4ZnTeO_8$ compound in which $Zn^{2+}$ will play a role of magneto-diluting agent and will preferentially substitute $Co^{2+}$ ions on tetrahedral sites. This compound, in turn, demonstrates spin-glass behavior with $T_c$ = 15 K. And small angle neutron scattering is an ideal instrument to probe both magnetically ordered and disordered states within this family of materials.

## Experimental

In the present research two samples were studied: $Co_5TeO_8$ and $Co_4ZnTeO_8$. Both samples are polycrystalline round pellets with radius r ≈ 0.5 cm and thickness h ≈ 0.03 cm. Small angle neutron scattering experiments were carried out on D33 SANS diffractometer with a wavelength λ = 6 Å. $Co_5TeO_8$ sample were measured at zero field within a temperature region between 20 and 155 K and then at 20, 32 and 36 K with an applied magnetic field from 0 to 7 T both: longitudinal and transverse. SANS data for $Co_4ZnTeO_8$ was also collected in a zero field first for a wide temperature region between 2 and 100 K with a subsequent transverse magnetic field scans between 0 and 7 T at 2, 7 and 10 K.

## Preliminary results

Zero field measurements for $Co_5TeO_8$ showed presence of isotropic magnetic scattering below $T_{c1}$ =45 K that changes its position from $|Q| \approx 0.07$ Å$^{-1}$ above $T_{c2}$ = 27 K and $|Q| \approx 0.1$ Å$^{-1}$ below, which is consistent with previous neutron powder diffraction experiments. Transverse magnetic field scans revealed some remarkable features. For field dependent measurement at 36 K Q-vector demonstrates an increase from |Q| = 0.8 to 0.95 Å$^{-1}$ upon raise of a magnetic field. For 32 K Q-vector increases at low fields from $|Q_1|$ = 0.068 to 0.073 Å$^{-1}$ up to 0.06 T at which additional anisotropic scattering with $|Q_2| \approx 0.1$ Å$^{-1}$ appears and the intensity from $Q_1$ redistributes into four features. For 0.07 T < H < 0.09 T there is a coexistence of these two features with $Q_1$ and $Q_2$ and for H > 0 only $Q_2$ feature is present on scattering patterns, the value of $Q_2$ in turn remains stable up to the highest values of the magnetic field (Fig. 1, 2). At 20 K isotropic magnetic scattering with $|Q| \approx 0.1$ Å$^{-1}$ which stays permanent with field growth. Longitudinal magnetic field scans didn't show any significant features on the whole range of magnetic field values.



**H = 0 T** **H = 0.06 T** **H = 0.07 T** **H = 0.09 T** **H = 1 T**

Figure 1. Field evolution of the scattering pattern for $Co_5TeO_8$ at 32 K

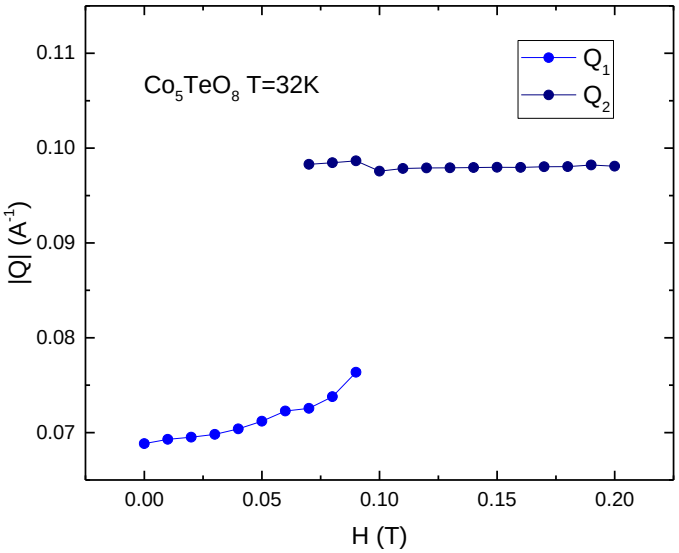



Figure 2. Field evolution of Q-vectors for $Co_5TeO_8$ at 32 K.

SANS measurements didn't show any sharp feature for $Co_4ZnTeO_8$ however upon cooling scattering patterns demonstrate an intensity enhance that points out a forming of short range ordered domains.