# Experimental Report



**Proposal:** **5-32-802** **Council:** 4/2014

**Title:** Two ground states in intermixed Mn1-xFexGe compounds

**This proposal is a new proposal**

**Researh Area:** Physics

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**Samples:** Mn1-xFexGe

| Instrument | Req. Days | All. Days | From | To |
|---|---|---|---|---|
| D33 | 5 | 4 | 25/09/2014 | 29/09/2014 |

**Abstract:**

We have synthesized powder Mn1-xFexGe samples within the concentration range of x = [0.0 - 1.0], which are magnetically ordered over the full concentration range. Small angle neutron scattering revealed the helical spin structure with a wavevector, which changes from a maximum |k| -> 2.3 nm-1 for pure MnGe, through its minimum (|k| -> 0) for x = 0.75 to a value of |k| ->0.09 nm-1 for pure FeGe [1].
Furthermore a second magnetic ground state has been revealed for the concentration range x [0.5 - 0.7]. The aim of this proposal is to collate the magnetic phase diagrams (H-T) within this critical concentration range.
[1] S. V. Grigoriev, et al., PRL 110, 207201 (2013).

Experiment No. 5-32-802: D33: 24.09 -29.09.2014

# ‘Two ground states in intermixed $Mn_{1-x}Fe_xGe$ compounds’

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Introduction:

The magnetic properties of the cubic transition metal monogermanides/silicides seem to be well investigated these days. These compounds having a non-centrosymmetric crystallographic structure described by $P2_13$ space group, produce Dzyaloschinksii-Moriya (DM) interaction. Below an ordering temperature Tc the DM interaction together with the ferromagnetic exchange produce a homogeneous helical spin structure. Recently a transformation of the helix into the ferromagnetic-like structure has been shown by mixing the two magnetic atoms Fe and Mn/Co in $Mn_{1-x}Fe_xGe$ [1,2] and $Fe_{1-x}Co_xGe$ [3] compounds. This transformation goes along with a flip of the link between the magnetic and structural chirality in this compounds.

Performed experiments:

We have performed magnetic field and temperature dependent SANS measurements for three different samples $Mn_{1-x}Fe_xGe$ (x= 0.5, 0.6, 0.7). A standard orange cryostat has been used for temperatures between 4 K and 250 K and in the magnetic field ranged between 0 and 3 T (applied perpendicular to the incoming neutron beam). We used a monochromatic beam with wavelength of 6 Å and 9 Å and a sample-detector distance between 6 and 12.8 m to cover the necessary Q-range.

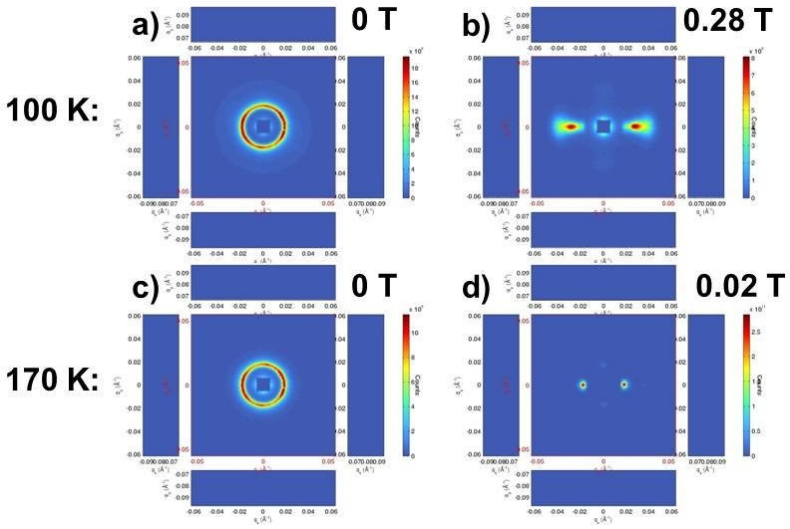


**Figure 1: SANS maps for 10 K with H = 0 T (a), 0.22 T (b) and for 170 K with H = 0 T (c) and 0.02 T (d).**

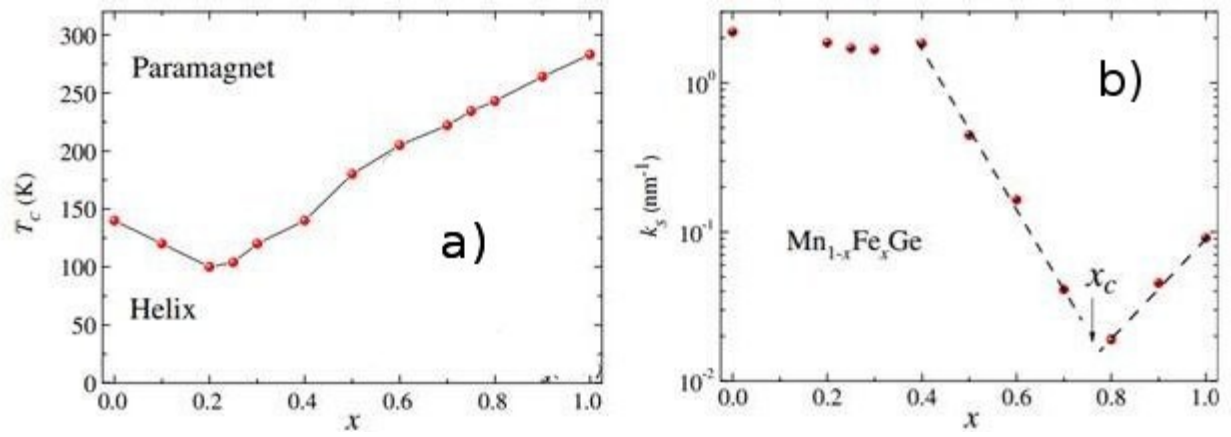


**Figure 2: Dependence of the ordering temperature $T_c$ (a) and the helix wavevector $k_s$ (b) of the concentration x [1].**

Results:

The first interpretation of our measurements provides the presumption of a different source of the observed scattering pictures. Opposite to our first assumption of a 'second magnetic ground state' in the concentration range between x = 0.5 and 0.7, it might be a decomposition of the x-concentration, which cause the different observed helices in the samples. In Fig.1 we show one example for the concentration x = 0.5 for two temperatures. For 170 K, above the ordering temperature for concentrations x < 0.5 (see Fig.2 a), the observed behavior is similar to the expected one for a pure compound (Fig.1 c and d). For 100 K, below the ordering temperature of the lower Fe-concentration compounds (x < 0.5), additional scattering at higher Q appears (Fig.1a and b). As it could be seen in Fig.2 b the k-values increase with decreasing x-concentration for the range 0.4 – 0.7. Further and complete data evaluation and interpretation is necessary to understand the observed phenomena in detail.

Miscellaneous:

D33 was working very well during our experiment; also the scientific and technical support was impeccable.

[1] S. V. Grigoriev, et al., PRL **110**, 207201 (2013).
[2] K. Shibata, et al., Nature Nano. **8**, 723-728 (2013).
[3] S. V. Grigoriev et al., PRB **90**, 174414 (2014).