Experimental Report

Proposal: **5-32-779** **Council:** 10/2012

Title: Magnetic correlations in Mn3GaC and Mn3GaCN

This proposal is a new proposal

Researh Area: Physics

Main proposer: **ACET Mehmet**

Experimental Team: ACET Mehmet
CAKIR Oznur

Local Contact: WILDES Andrew

Samples: Mn3GaC
Mn3Ga(C0.85N0.15)

Instrument	Req. Days	All. Days	From	To
D7	4	4	07/06/2013	11/06/2013

Abstract:

Mn3GaC undergoes a first order antiferromagnetic-ferromagnetic (AF_FM) transition at Ti = 160 K and a second order ferromagnetic-paramagnetic (PM) transition at TC = 250 K. Substituting partially carbon with nitrogen [Mn3Ga(C0.85N0.15)]causes Ti to increase to 180 K whereas TC drops such that it lies virtually below Ti, i.e. long-range ferromagnetism does not occur and only strong ferromagnetic correlations can be observed in the temperature dependence of the magnetization. These materials show field induced transformations from the low-temperature AF state to the high temperature FM (or FM correlated) state giving rise to large magnetocaloric effects. Using polarization analysis and neutron depolarization, we aim to study the nature of magnetic correlations as the first order transition is approached and at high temperatures, above the second order transition, to examine whether mixed AF and FM correlations appear already at temperatures well in the PM regime.

We have conducted neutron depolarization and polarization analysis experiments for Mn_3GaC and $Mn_3GaC_{0.85}N_{0.15}$. The temperature dependence of the magnetization of the particular samples used are given in fig.1, and fig.2 As shown in fig.1, in Mn_3GaC, there are two magnetic transitions: a first-order antiferromagnetic (AF) to ferromagnetic (FM) magnetostructural transition at T_t =165 K and a second-order FM to paramagnetic (PM) transition at the Curie temperature T_C = 250 K. In fig.2, for $Mn_3GaC_{0.85}N_{0.15}$, as the temperature decreases from 380 K to 175 K, M increases tending to approach a FM state. However, before T_C is reached, a transition to the AF state occurs at T_t, below which the magnetization rapidly decreases.

In fig.2a, the depolarization result is presented for Mn_3GaC as the temperature dependence of the flipping ratio. At 350 K, the flipping ratio value is 50 until down to T_C. At this temperature, it decreases sharply and reaches a value of 30. This value remains constant until T_t. Below T_t, it increases back up to 50. On the other hand, in $Mn_3GaC_{0.85}N_{0.15}$ there is no change in the flipping ratio. According to these results, ferromagnetic domains are not present ion this sample, and this is evidence that any long-range ferromagnetic ordering is absent in $Mn_3GaC_{0.85}N_{0.15}$.

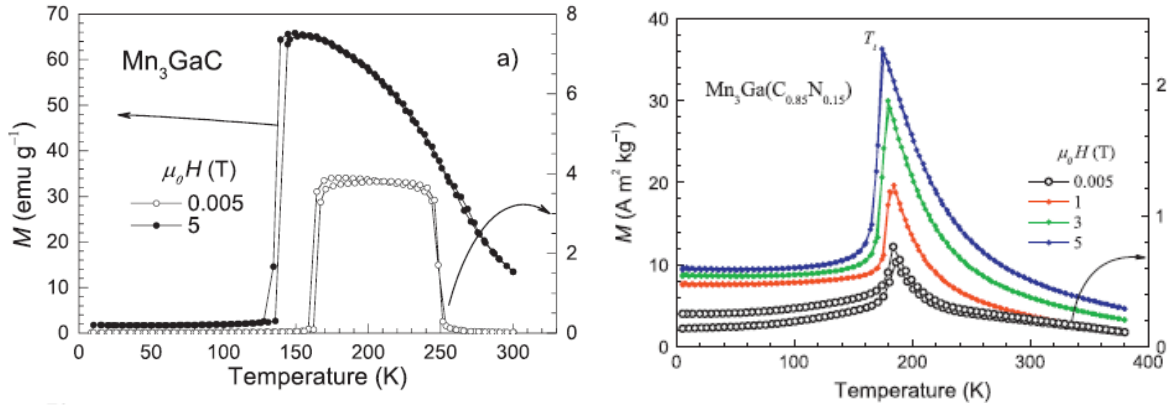


Fig1: Temperature dependence of the magnetization measurements. (a) under 5 mT (right scale) and 5T (left scale) for Mn_3GaC. (b) under 5 mT (right scale) and 1, 3, 5 T (left scale) for $Mn_3GaC_{0.85}N_{0.15}$

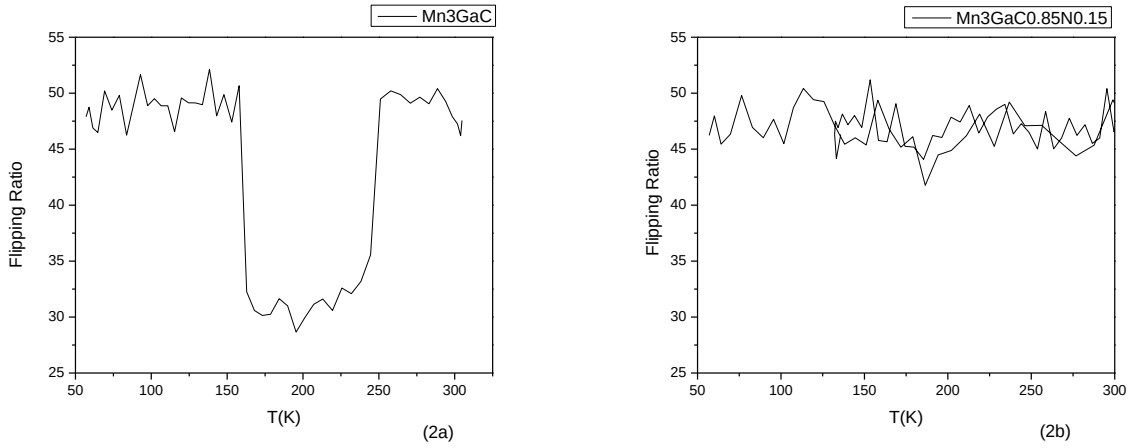


Fig2. Temperature dependence of value of flipping ratio for (a) Mn_3GaC and (b) $Mn_3GaC_{0.85}N_{0.15}$.

In Fig 3a, the total and magnetic scattering cross sections are shown for Mn_3GaC. According to the total scattering, for Mn_3GaC, reflections at positions corresponding to Bragg scattering from the crystallographic lattice is observed between 500 K and 300 K. At 50 K and 150 K additional reflections at lower *q* appear which are related to antiferromagnetic ordering according to fig. 1a. These reflections are seen to be related to antiferromagnetism as seen in the *q*-dependence of the magnetic cross section given in fig.3b. At 150 K, a single reflection a q = 1.40 A^{-1} is observed whereas, at 50 K additional reflections at q = 1.00 A^{-1} and q = 1.48 A^{-1} are observed. This result indicates that a new antiferromagnetic structure is formed at low temperatures. The data are presently being refined.

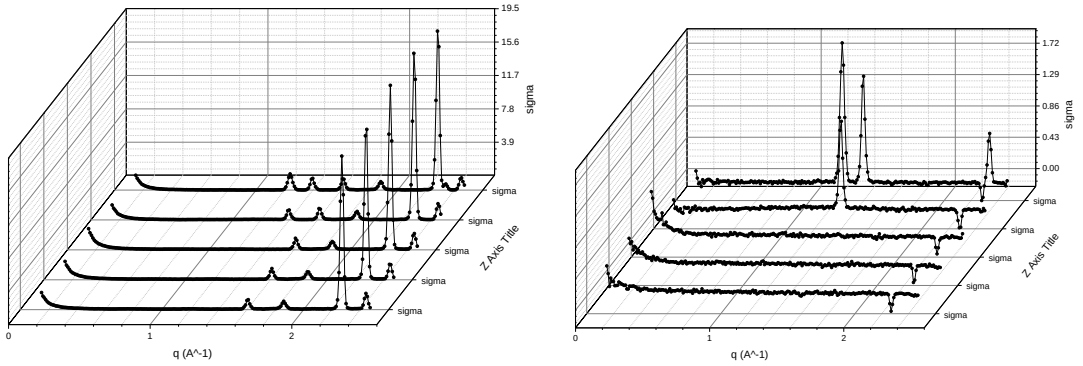
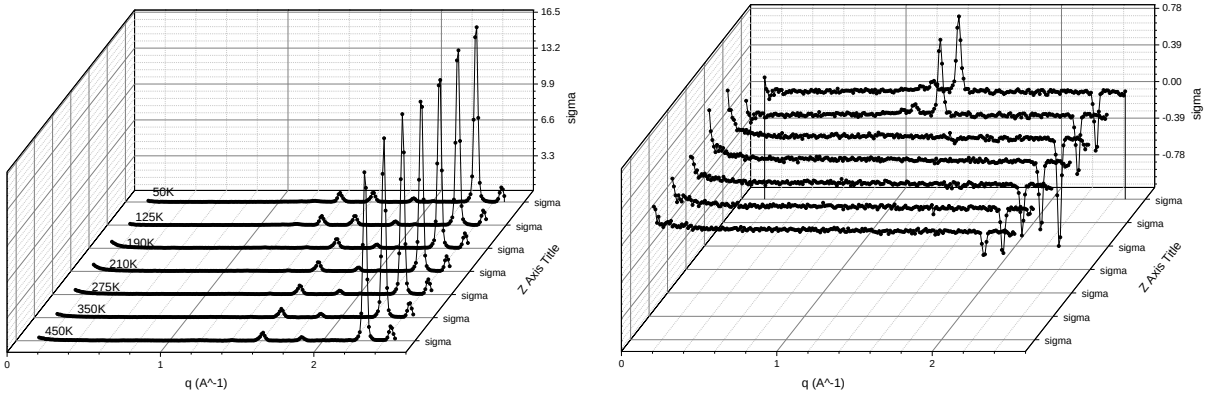


Fig 3 the total and magnetic scattering cross sections for Mn_3GaC (a) total (b) magnetic

In Fig 4a, the total and magnetic scattering cross sections are shown for Mn_3GaCN. According to the total scattering, for Mn_3GaCN, reflections at positions corresponding to Bragg scattering from the crystallographic lattice is observed between 450 K and 190 K. At 50 K and 125 K additional reflections at lower *q* appear which are related to antiferromagnetic ordering according to fig. 1b. These reflections are seen to be related to antiferromagnetism as seen in the *q*-dependence of the magnetic cross section given in fig.4b. The reflections related to antiferromagnetic ordering are located at q = 1.23 A^{-1} q = 1.40 A^{-1}.

Additionally, strong forward scattering related to the presence of ferromagnetic correlations is observed for both samples in the paramagnetic regimes. The forward scattering weakens with increasing temperature.



(a) (b)

Fig. 4 the total and magnetic scattering cross sections for Mn_3GaCN (a) total (b) magnetic