Experimental Report

10/01/2014

Proposal: **5-41-678** **Council:** 10/2011

Title: Magnetic structure of the multiferroic kagome staircase compound (Co0.1Ni0.9)3V2O8 under magnetic field

This proposal is continuation of: 5-41-596

Researh Area: Physics

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Samples: (Co0.1Ni0.9)3V2O8

Instrument	Req. Days	All. Days	From	To
D10	7	7	25/10/2012	01/11/2012

Abstract:

The aim of the proposed experiment is to study the magnetic structure of multiferroic (Co0.1Ni0.9)3V2O8 under magnetic field. The pure Co and pure Ni compounds exhibit substantially different magnetic phase transition sequences and magnetic structures. The partial substitution of one ion by the other again brings new magnetic properties. Surprisingly, doping a small percentage of Co into the pure Ni compound stabilizes the multiferroic phase down to low temperature. We have studied the magnetic structures in (Co0.1Ni0.9)3V2O8 at zero field which differ from those in Ni3V2O8. Bulk magnetization data reveal a field dependent magnetic phase transition from the low-temperature incommensurate phase into a supposedly canted antiferromagnet phase. From our present knowledge we assume that the magnetic structure of this canted phase has to be different from the one in the pure Ni compound. We propose to study this magnetic structure in detail. Furthermore, field and temperature dependent studies of representative magnetic reflections should be carried out across the different magnetic phase transitions.

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Magnetic structure of the multiferroic kagome staircase compound $(Co_{0.1}Ni_{0.9})_3V_2O_8$ under magnetic field

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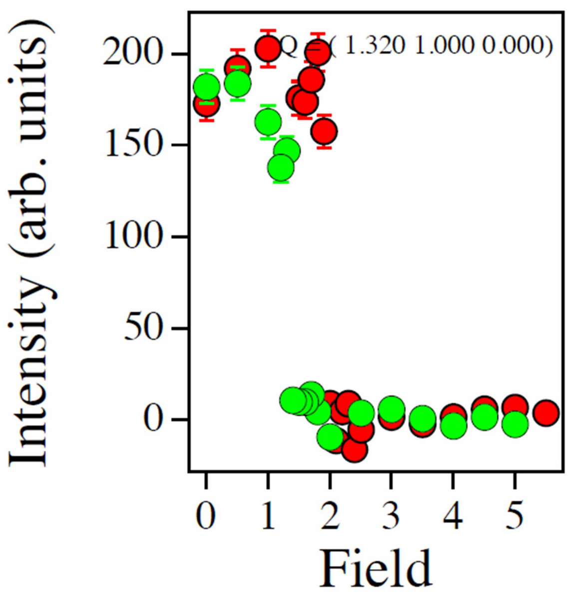
In this experiment the magnetic structures of $(Co_{0.1}Ni_{0.9})_3V_2O_8$ (CNVO) have been determined under an applied magnetic field along the crystallographic *c* axis. The same sample as for our previous zero-field experiment [published in PRB 88, 174412 (2013)] was used.

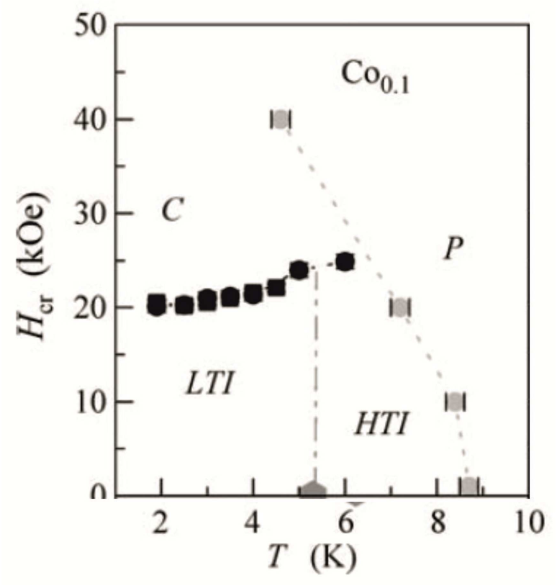
The nuclear structure was investigated by recording 116 unique Bragg reflections. The intensities were corrected for absorption and the extinction was treated by an empirical ShelX-like approach. All nuclear structure parameters were taken from the zero-field experiment leaving only the scale factor as a refinable parameter. The refinement yields an R_F of 6.8.

For the magnetic structure investigation at T = 1.6 K and H = 0 T a total number of 118 unique Bragg reflections have been measured. The data is consistent with our previous measurement and the spin spiral could be refined with R_F=10.9. The values of the magnetic moments are the same within the error bars compared to the zero-field experiment.

88 magnetic reflections have been measured at the same conditions (T = 1.6 K, H = 0 T), however, after ramping the field up and down. The propagation vector changes from k=(0.322 0 0) to k=(0.306 0 0). Furthermore, a significant hysteresis can be observed in the integrated intensities of the magnetic reflections (see Figure below).

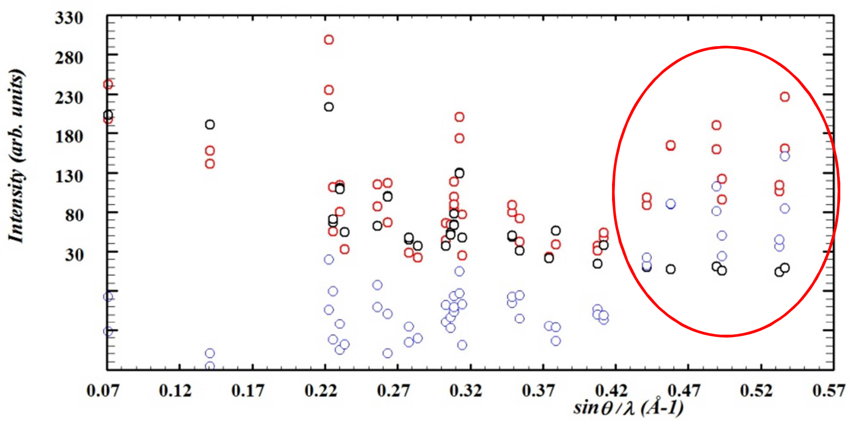


In the resulting magnetic structure the envelope of the spine spins is 0.1 μ_B smaller than before. Presumably, the loss of intensity should be found on the k=0 magnetic reflections according to the C-structure which is reached by applying the magnetic field [see phase diagram below, from JETP Lett. 91, 147 (2010)].



The nuclear structure has been checked at T = 1.5 K and H = 3 T revealing no significant change with applied magnetic field (R_F=7.1). The magnetic reflections could be explained with the magnetic structure model corresponding to the C-phase, where the cross-tie spins on the 4a site point along the *b* axis and the spine spins on the 8e site point along the *a* axis. The refined values are 0.7(1) μ_B and 1.8(1) μ_B for the cross-tie and the spine spins, respectively.

A further magnetic data collection has been done at T = 4.5 K with an applied field of H = 1 T i.e. still in the LTI phase and the refinement of the data confirms the spin spiral sructure. However, we have observed an increase of intensity towards higher sinθ/λ values which we have not yet understood. A possible explanation might be a structural modulation (eventually the O ions).



A final data collection has been done at T = 7 K and H = 5.5 T in the P phase, which is topologically equivalent to the C phase with the refined magnetic moments S_c=0.2(1) μ_B and S_s=1.3(1) μ_B.