Experimental report

27/05/2026

Proposal: EASY-1480 **Council:** 10/2024

Title: Resolution of the incommensurate contributions to the magnetic propagation vector in Mn2InNbO6 and Mn2InTaO6

Research area: Materials

This proposal is a new proposal

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Experimental team:

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Samples: Mn2In(Nb,Ta)O6

Instrument	Requested days	Allocated days	From	To
XTREMED	24	24	06/07/2025	07/07/2025

Abstract:

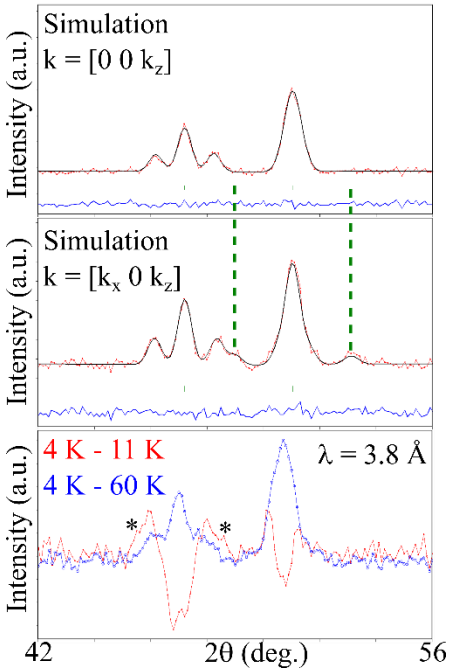
Mn2InNbO6 and Mn2InTaO6 have recently been studied. D20 data collected at low temperatures reveal their different thermal evolution, where the niobate develops a simple AFM structure with k = [0 0 0] but an incommensurate structure competes at low temperature in the tantalate. The incommensurate contribution does not fit a simple [0 0 kz] propagation vector from the 2K-30K difference pattern, but an additional kx contribution is required. However, the use of the standard 2.42 A and 2.45 A wavelengths at D20 and XtremeD respectively does not allow to fully resolve the satellites arising from the short kx contribution. For this reason, an EASY experiment is requested to collect a long scan at 2K using the longer 3.8 A wavelength. This will enable the complete splitting of the two different sets of satellite peaks around (101) nuclear peak, which remain convoluted in the preliminary data. Nb is similar to Ta by all means, so the two isostructural compounds are expected to show a similar behaviour. Collecting data on XtremeD using the mentioned long wavelength will confirm this similarity.

Resolution of the incommensurate contributions to the magnetic propagation vector in Mn_2InNbO_6 and Mn_2InTaO_6

ABO_3 oxides accommodate a wide variety of chemical compositions, crystallize with several structures in competition and develop diverse physical properties, being intensively studied in the search for new functional materials. Among them, transition metal oxides with corundum related structures, have proven of notable interest in the context of frustrated magnets, correlated electrons and Kitaev physics, due to their honeycomb lattices.

In this context, we recently studied Mn_2InNbO_6 and Mn_2InTaO_6. D20 data (experiment 5-31-2968) collected at low temperatures reveal their different thermal evolution, where the niobate develops a simple AFM structure with k = [0 0 0] but an incommensurate structure competes at low temperature in the tantalate. The incommensurate contribution does not fit a simple [0 0 k_z] propagation vector from the 2K-30K difference pattern, but an additional k_x contribution is required. Further neutron studies have been perfomed in XtremeD (experiment CRG-3246) to study the effect of an applied magnetic field on the evolution of this complex magnetic structure.

However, the use of the standard 2.42 Å and 2.45 Å wavelengths at D20 and XtremeD respectively does not allow to fully resolve the satellites arising from the short apparent k_x contribution. For this reason, EASY-1480 experiment was requested to collect a long scan at 2K using the longer 3.8 Å wavelength. This should complete the splitting of the satellite peaks. According to our simulations (Fig. 1, top and middle), this should enable to discern if only one (k =[00k_z]) or two (k = [k_x 0 k_z]) different sets of satellites appear around (101) nuclear peak, which remain convoluted in the preliminary data.



Raw data at base temperature, was however not enough to confirm whether both incommensurate components are present or not. Data sets were therefore collected at 4, 11 and 60 K (below, between and above the magnetic transitions) for analysis of the difference patterns. Bottom panel of Fig. 1 reveals a single k_z contribution, with harmonic peaks (*) around (003) and thermal evolution of the propagation vector.

It is notable that Nb is similar to Ta by all means, so the two isostructural compounds are expected to show a similar behaviour. The collected data on XtremeD using the long wavelength confirmed the expected closer behaviour between both compounds.

Figure 1. Simulated patterns of Mn_2InTaO_6 main magnetic signals for k = [00k_z] (top) and k = [k_x0k_z] (middle) using λ = 3.8 Å. Green dashed lines highlight the additional peaks arising from k_x contribution. Experimental difference patterns (bottom) showing reorientation of the k = [000] contribution into a [00 k_z] propagation vector. 2nd harmonic signals of k_z are identified with *.

These results provided the required information to report a comprehensive compared study of Mn_2InNbO_6 and Mn_2InTaO_6 materials. [1]

References: [1] E. Solana-Madruga *et al. Manuscript in preparation* (2026).