Experimental report

09/03/2020

Proposal: 5-31-2585 **Council:** 4/2018

Title: Influence of the rare earth singleion anisotropy on the magnetic order in the pyrochlore iridate Er2Ir2O7

Research area: Physics

This proposal is a new proposal

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Samples: Er2Ir2O7

Instrument	Requested days	Allocated days	From	To
D20	3	3	21/09/2018	24/09/2018
D2B	1	1	24/09/2018	25/09/2018

Abstract:

The all in all out type magnetic order has been recently established for both magnetic sublattices in the pyrochlore iridates Tb2Ir2O7 and Nd2Ir2O7. For Er2Ir2O7 the study of a different group determined that the Er-sublattice does not order. This was linked to the incompatibility of the easy plane anisotropy of the Er-ion with the all in all out magnetic order of the Ir-sublattice. However, the suspected magnetic order of the Ir-sublattice has not been seen in their experiment. We want to remediate this point by determining directly by high intensity powder diffraction and the use of difference patterns the magnetic order and the size of the iridium moment.

Influence of the rare earth single ion anisotropy on the magnetic order in the pyrochlore iridate $Er_2Ir_2O_7$

The 5*d* transition metal oxides have attracted much attention due to the relatively large spin-orbit coupling (SOC) which may lead to a novel j_{eff} = 1/2 state, for which a metal-insulator transition (MIT) can be realized with a moderate electron-electron correlations. Such a MIT concomitant with an antiferromagnetic transition is indeed observed in the pyrochlore iridate R2Ir2O7. Recently, we have succeeded in determining the magnetic structure of Nd2Ir2O7 and Tb2Ir2O7 directly from high intensity neutron powder diffraction measurements performed on the D20 diffractometer.[1,2] It was showed that the Ir sublattice forms the so-called all-in/all-out (AIAO) magnetic structure at high temperatures, and the rare earth sublattice forms the same AIAO structure at lower temperatures due to the d-f interaction, with a small deviation from the ideal local <111> direction for the Tb sublattice due to f-f interaction. Another study by Lefrançois et al. on Er2Ir2O7 suggested that due to the XY anisotropy at the Er site, which is incompatible with that of the Ir site, the Er ions is paramagnetic down to the lowest temperature. However, in their studies, they only measured below 50 K, which is far below the transition temperature for the Ir sublattice. Thus, it is impossible to resolve the magnetic ordering on the Ir sublattice.

Here, we have performed powder neutron diffraction measurements on Er2Ir2O7 using the D20 diffractometer. The samples have been loaded into a hollow vanadium can in order to reduce the neutron absorption by Ir ions, and measured by about 20 hours at each temperature in order to obtain good statistics. In order to subtract the high temperature pattern from the low temperature one properly, the peak positions at low temperatures have been shifted by changing the wavelength so that the peaks appear at the same 2th positions compared to the high temperature ones. The difference pattern (10 K – 145 K) is shown in Fig. 1. The subtraction is still not perfect, but already much improved compared to that without shifting peak positions. At low temperature, the Er moments are short-range correlated, which results in the diffusive background. Ignoring this diffusive contributions, and taking into account the weak signals, we only concentrated on the peaks expected for the AIAO magnetic structure, a fit to the AIAO structure on the Ir sublattice only yields a magnetic moment of 0.47(2) μ_B/Ir. This value is a bit smaller than that of the Tb2Ir2O7 sample (0.55(3) μ_B/Ir). Recognizing that the magnetic transition temperatures for Er2Ir2O7 and Tb2Ir2O7 are 140 K and 125 K, respectively, it may suggest that the fluctuation of Er moments at low temperatures suppresses the ordering of the Ir sublattice.

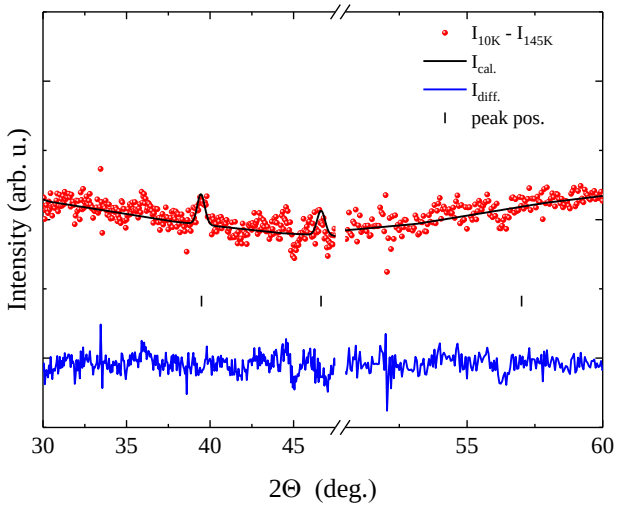

Fig. 1 The difference pattern of $Er_2Ir_2O_7$. The black curve is simulated with the AIAO magnetic structure at the Ir site with 0.47 μ_B/Ir.

References:

[1] H. Guo, C. Ritter and A. C. Komarek, Phys. Rev. B 94, 161102(2016).
[2] H. Guo, C. Ritter and A. C. Komarek, Phys. Rev. B 96, 144415 (2017).