# Experimental report

27/02/2019

**Proposal:** 5-41-940 **Council:** 4/2017

**Title:** 2-k magnetic structure of a distorted kagome-lattice antiferromagnet Ho3Ru4Al12

**Research area:** Physics

**This proposal is a resubmission of 5-41-897**


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**Samples:** Ho3Ru4Al12

| Instrument | Requested days | Allocated days | From | To |
|---|---|---|---|---|
| D10 | 7 | 6 | 02/04/2018 | 08/04/2018 |


## Abstract:

R3Ru4Al12 (R is a rare-earth atom or uranium) crystallize in a hexagonal crystal structure where the R atoms form distorted kagome nets and are therefore subject to geometrical frustration. In the present project, we would like to study the Ho3Ru4Al12 compound. Ho3Ru4Al12 displays an antiferromagnetic ordering below the Neel temperature, TN = 4 K, with a possible incomplete ordering of the Ho magnetic moments. Our preliminary data collected using the Cyclops Instrument at the ILL indicate that the magnetic structure of Ho3Ru4Al12 may be described by two distinct propagation vectors. We would like to perform neutron-scattering experiments on a single crystal of Ho3Ru4Al12 in order to determine the magnetic structure of the compound. Among R3Ru4Al12, Ho3Ru4Al12 deserves special attention since (i) the Ho moments might be ordered incompletely, (ii) two propagation vectors seem to be necessary to describe its magnetic structure, and (iii) a second magnetic transition, possibly related to a pre-ordering of the magnetic moments, appears around 15 K. The proposed study is expected to contribute to the rich physics of geometrically frustrated compounds.

# "2-$k$ magnetic structure of a distorted kagome-lattice antiferromagnet $Ho_3Ru_4Al_{12}$" (no. 5-41-940)

In $Ho_3Ru_4Al_{12}$, the Ho atoms form a distorted kagome lattice and the Ho magnetic moments are likely subject to geometrical frustration. Our macroscopic data obtained using magnetization, specific-heat, and electrical-resistivity measurements suggest incomplete ordering of the Ho moments at 4.5 K [1]. This experiment aimed to (i) clarify the nature of the transition at 4.5 K and (ii) investigate the magnetic structure of the $Ho_3Ru_4Al_{12}$ compound.

Figure 1 shows the temperature dependences of the intensity of selected reflections. There are two magnetic reflections, (1/3, 1/3, 9/10) and (-2/3, 2/3, 1/2), corresponding to the incommensurate magnetic propagation vectors, $k_1$ = (1/3, 1/3, 9/10) and $k_2$ = (2/3, 1/3, 1/2). A magnetically ordered state in $Ho_3Ru_4Al_{12}$ sets in in two steps. The onset of the magnetic order is at 4.5 K. It is characterized by the vector $k_1$. At a lower temperature, 3.5 K, the other satellite reflections appear and can be indexed by the $k_2$ vector. The (1 1 0) reflection is nuclear. It has a constant intensity in the whole temperature range, showing that there is no additional contribution from a zero magnetic propagation vector to the magnetic structure.

At present, we are working on refining the magnetic structure of $Ho_3Ru_4Al_{12}$ using some of the computational tools available at the Bilbao Crystallographic Server [2] and the program Jana2006 [3,4].

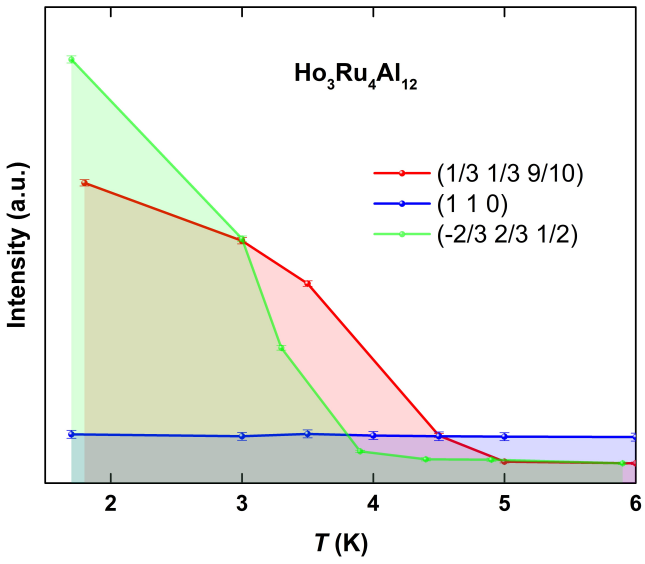


FIG. 1: Temperature dependences of the integrated intensities of selected magnetic reflections of $Ho_3Ru_4Al_{12}$.

## References


[1] D. I. Gorbunov, T. Nomura, I. Ishii, M. S. Henriques, A. V. Andreev, M. Doerr, T. Stöter, T. Suzuki, S. Zherlitsyn, and J. Wosnitza, Phys. Rev. B **97**, 184412 (2018).

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[3] V. Petříček, M. Dušek, and L. Palatinus, Z. Kristallogr. **229**, 345 (2014).

[4] V. Petříček, M. S. Henriques, and M. Dušek, Acta Phys. Pol. A **130**, 848 (2016).