Experimental Report

02/12/2013

Proposal: **5-41-743** **Council:** 10/2012

Title: Magnetic order in Nd2RhIn8

This proposal is continuation of: 5-41-610

Researh Area: Physics

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Samples: Nd2RhIn8

Instrument	Req. Days	All. Days	From	To
D10	4	4	28/03/2013	01/04/2013

Abstract:

Nd2RhIn8 belongs to a large family of structurally closely related materials characterized by the general formula RmTnX3m+2n. This broad family of compounds is of particular interest as it involves several archetypal unconventional superconductors. Previous studies of magnetic structures in NdRhIn5, CeRhIn5 and NdIn3 revealed some contrary behavior which was tentatively ascribed to competing (NdIn3, CeRhIn5) or matching (NdRhIn5) crystal-field and exchange interaction anisotropies. Regarding dimensionality, Nd2RhIn8 lies just between NdIn3 and NdRhIn5 and the knowledge of its magnetic structure is desirable for drawing more definite conclusions about the role of dimensionality and anisotropy in the development of AF structures in this family of compounds. It is a continuation of Laue-diffraction experiment (5-41-610) on VIVALDI which revealed (½ ½ ½) propagation, different from that in NdRhIn5 or NdIn3.

Nd_2RhIn_8 belongs to a large family of structurally closely related materials characterized by the general formula $R_mT_nX_{3m+2n}$. This broad family of compounds is of particular interest as it involves several archetypal unconventional superconductors. Previous studies of magnetic structures in $NdRhIn_5$, $CeRhIn_5$ and $NdIn_3$ revealed some contrary behavior which was tentatively ascribed to competing ($NdIn_3$, $CeRhIn_5$) or matching ($NdRhIn_5$) crystal-field and exchange interaction anisotropies [1]. Regarding dimensionality, Nd_2RhIn_8 lies just between $NdIn_3$ and $NdRhIn_5$ and the knowledge of its magnetic structure is desirable for drawing more definite conclusions about the role of dimensionality and anisotropy in the development of AF structures in this family of compounds. It was a continuation of Laue-diffraction experiment (5-41-610) on VIVALDI which revealed a (½ ½ ½) propagation [2], different from that in $NdRhIn_5$ or $NdIn_3$.

To determine the magnetic structure in Nd_2RhIn_8, we have performed an experiment on the D10 diffractometer at a wavelength $\lambda = 2.36$ ˚A. The reflections were measured as ω-scans. First the sample was cooled to 2 K and cell parameters and orientation were refined on the basis of 41 strongest nuclear reflections using program rafd9. Then set of 364 (70 nonequivalent) nuclear and 461 (50 nonequivalent) magnetic reflections was taken at 2 K. To exclude possibility of existence ferromagnetic component, we also measured 13 random nuclear reflections at 15 K. At the end of experiment, temperature dependencies of one magnetic and two nuclear reflections were taken. All reflections were integrated using program racer and reduced using program DataRed. Program Fullprof was used for the refinement of the nuclear and magnetic structures. The extinction correction was refined using Zachariasen formula [4] with anisotropic correction (Ext-Model=4 in Fullprof software).

The comparison of intensities of nuclear reflections at 30 K and 2 K did not reveal any increase between 30 and 2 K, indicating that there is no ferromagnetic component in the magnetic structure of Nd2RhIn8. The determined structural parameters are given in Table 1.

The magnetic structure has been then determined also by using the representation analysis. The final determined magnetic structure is shown in Fig.1. The size of the Nd magnetic moments (see also Table 1) amounts 2.5 μ_B in a very good agreement with our previous magnetization data. The observed and calculated intensities of both, nuclear and magnetic reflections are shown in Fig. 2.

For the magnetic reflection, the intensities were additionally fitted to the power law $I \sim (T_N - T)^{2\beta}$, resulting in $\beta = 0.21 - 0.29$. This value suggests 3D character of magnetic ordering.

References:

[1] P. Čermák, ILL experimental report 5-41-610.

[2] S. Chang et al., Phys. Rev. B 66 (2002) 132417.

[3] W. H. Zachariesen, Acta Cryst. 23, 558 (1967).

TABLE I: Structural and magnetic parameters of Nd_2RhIn_8 at T=2 K.

lattice parameters				
	a	c	V	
	4.6213(9)	12.113(3)	258.68	
atomic positions				
atom	x	y	z	moment (μ_B)
Nd (1)	0	0	0.3083(3)	2.53(4)
Nd (2)	0	0	0.6917(3)	2.53(4)
Rh	0	0	0	
In (1)	0	0.5	0.5	
In (2)	0.5	0.5	0.3059(6)	
In (3)	0	0.5	0.1212(4)	
reliability factors				
	RF^2	RF	χ^2	
nuclear	6.70	5.34	3.14	
magnetic	15.5	9.83	6.01	

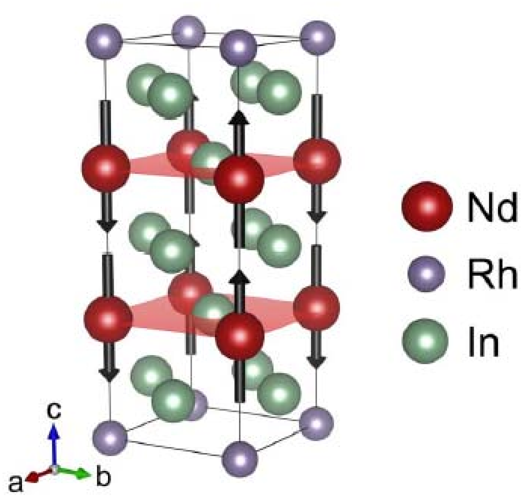

Fig. 1: Magnetic structure of Nd_2RhIn_8.

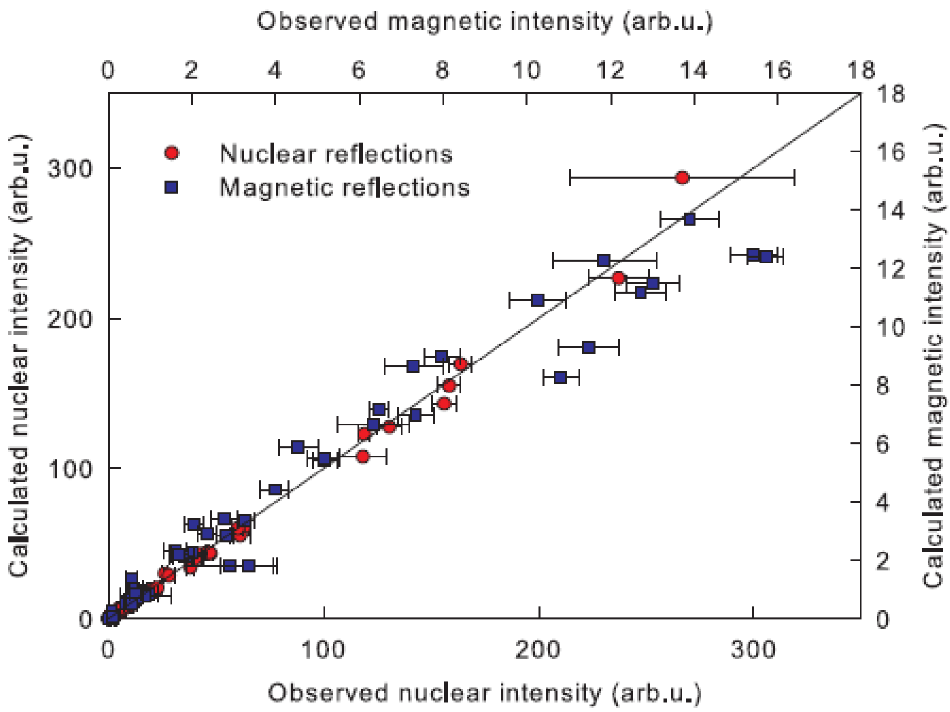

Fig. 2.: Observed and calculated nuclear and magnetic intensities. The calculated intensities correspond to the parameters given in Table 1. We use arbitrary units, but all the values are scaled together in the same way.

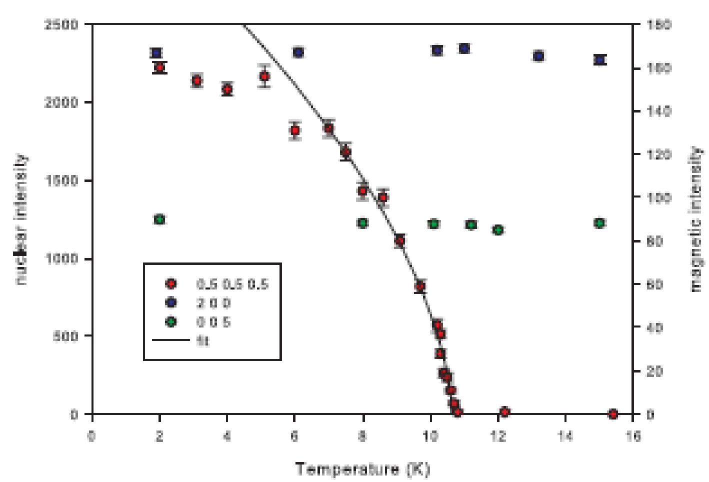

Fig. 3: Temperature dependence of intensities of selected reflections. The full line is a fit to $I \sim (T_N - T)^{2\beta}$.