Experimental report

14/09/2023

Proposal: DIR-231 **Council:** 10/2020

Title: Magnetic structures in intermetallics of the Eu-Pd-Sn system

Research area: Materials

This proposal is a resubmission of 5-31-2763

Main proposer: Alberto MARTINELLI

Experimental team: Alberto MARTINELLI

Local contacts: Clemens RITTER

Samples: EuPdSn2
Eu2Pd2Sn

Instrument	Requested days	Allocated days	From	To
D20	3	2	23/05/2021	25/05/2021

Abstract:

The anomalous behaviors of Eu and Yb attracted much interest in intermetallic compounds containing these 2 rare earths (RE). In fact, RE are usually found in a 3+ state, but Eu and Yb can also exhibit a 2+ state or even intermediate valence. Examples of these anomalous effects in Eu and Yb-based intermetallics are heavy fermion behavior, Kondo interactions and superconductivity. Compared with Yb compounds, much less studies were devoted to Eu compounds, due to the fact that synthesis is made even more difficult (both have a high vapor pressure) because Eu is more sensitive to oxygen and moisture.

We aim to investigate the magnetic structures of 2 new compounds EuPdSn2 and Eu2Pd2Sn, both exhibiting a 2+ state and ordered magnetic Eu state, as inferred by inverse susceptibilities measurements. To overcome the problems related to the strong Eu neutron absorption, we will use a large-area flat-plat geometry sample holder (see the technical documentation file), already used at D20 diffractometer for detecting magnetic moment as low as 0.5 mB at the Sm site in SmFeAsO.

In the last 2 calls the proposal was accepted (A7.3 and A7.5) but could not be awarded beam time due to national balance

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19/04/2022

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REPORT OF THE EXPERIMENT ILL-DIR-231

TITLE: **Magnetic structures in intermetallics of the Eu-Pd-Sn system**

The magnetic structures of $EuPdSn_2$ and Eu_2Pd_2Sn were investigated by means of neutron powder diffraction using the ILL-diffractomenter D20.

$EuPdSn_2$

$EuPdSn_2$ crystallizes in the *Cmcm* space group with Eu is located at the 4*c* Wycoff site.

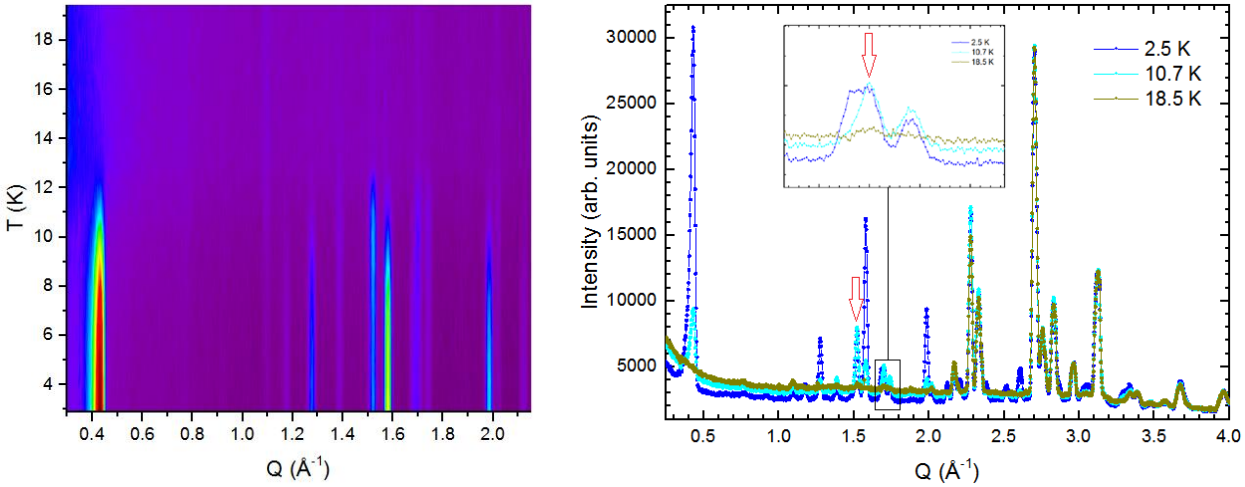

Figure 1. On the left: the thermal dependence of the magnetic peaks intensities below ~ 20 K. On the right: Superposition of the NPD patterns at three different temperatures.

Magnetic peaks are observed for T < 12K. At first glance, all the magnetic peaks arise at about the same temperature in the NPD patterns (Figure 1 on the left).

The Figure 1 on the right shows NPD patterns collected at three different temperatures. The magnetic peaks at 1.51 and 1.69 Å^{-1} exhibits the same intensities at 10.7 and 2.5 K; conversely, all the remaining magnetic peaks exhibit a remarkable increase of their intensities cooling from 10.7 K down to 2.5 K. This behavior suggests the possible coexistence of two different magnetic orderings. Figure 2 shows the Rietveld refinement plot and the observed magnetic orderings.

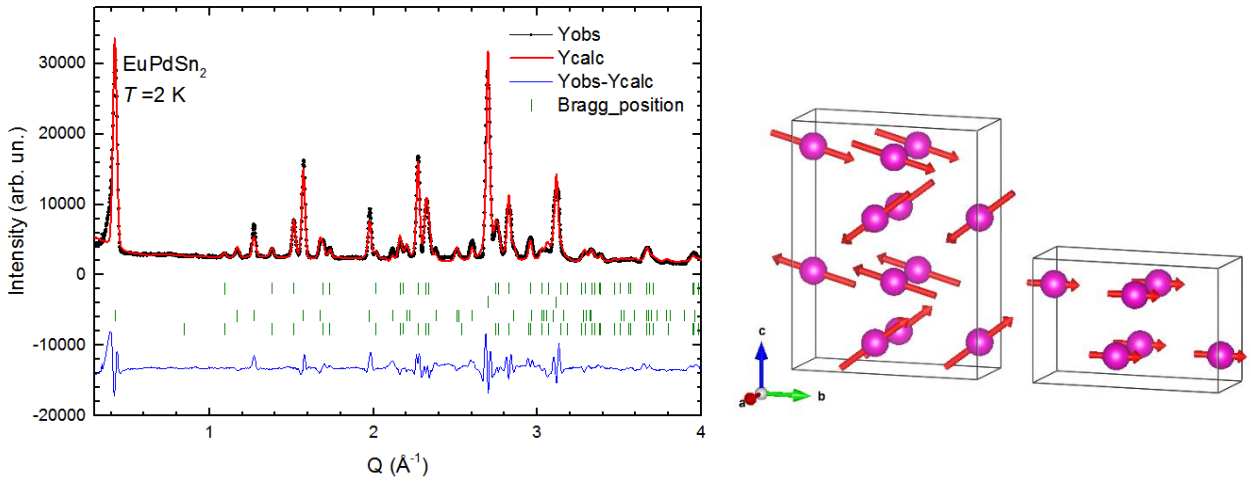

Figure 2. On the left: Rietveld refinement plot obtained by using NPD data collected at 2.5 K. On the right: AFM and FM ordering of the magnetic moments of the Eu atoms.

Attempts to identify a single magnetic vector fitting all the magnetic peaks were carried out. As a result, no commensurate vector can be found. Attempts to refine the magnetic structure using different incommensurate vectors were carried out, but none of these models can satisfactory fit the data.

NPD data can be fitted by applying a structural model foreseeing the coexistence of two different magnetic ordering:

1) An AFM structure with magnetic propagation vector **k** = (0,0,½).
2) A FM structure with magnetic moments aligned along the *b* axis.

Eu_2Pd_2Sn

Eu_2Pd_2Sn crystallizes in the *Fdd*2 space group with Eu is located at the 16*b* Wycoff site.

Magnetic peaks are observed for $T < 13$K. The magnetic structure is not commensurate; attempts are still in progress in order to determine the exact magnetic moment ordering. Figure 3 shows the thermal evolution of the magnetic peaks.

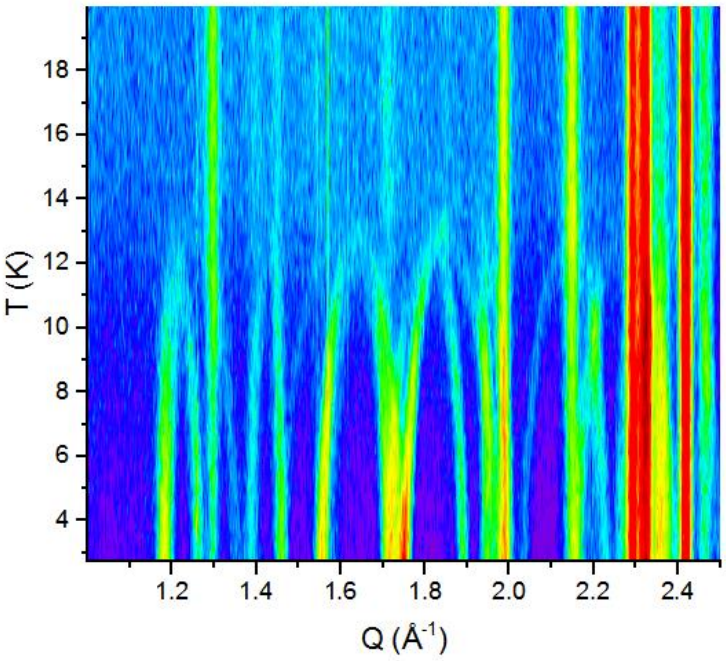

Figure 3. Thermal dependence of the magnetic peaks intensities of Eu_2Pd_2Sn below ~ 20 K