Experimental report

17/02/2025

Proposal: **5-31-2776** **Council:** 4/2020

Title: Probing Hidden Order (HO) in the YbPd2In ground state through neutronpowder diffraction

Research area: Materials

This proposal is a resubmission of 5-31-2705

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Samples: YbPd2In

Instrument	Requested days	Allocated days	From	To
D20	2	2	17/03/2021	19/03/2021

Abstract:

The issue of Hidden Order (HO) is one of the most intriguing in solid state physics and it refers to materials where a clear phase transition occurs but the nature of the order parameter is unknown. The prototype compound for HO is URu2Si2, which shows a puzzling transition at ~ 17 K. In particular, neutron diffraction analyses evidenced an AFM order in the HO state, with an ordered-moment (~0.02 mB) too small to account for the observed macroscopic behavior. Despite decades of intensive research, no consensus yet emerged regarding the microscopic nature of the HO. In the search of new intermetallic compounds showing similar properties, the recently synthesized compound YbPd2In fulfills these characteristics showing a notably similar Bcr/Tcr ratio between the critical field (Bcr), at which the ordered phase is suppressed, and the temperature (Tcr) of the transition at B=0. The low Bcr ~0.8T and the corresponding low Tcr ~ 250mK values of YbPd2In offer the opportunity to get rid of spurious effects originated in the high values of Br ~ 34T and Tcr ~ 17K of URu2Si2. Neutron diffraction analysis represents a fundamental technique to shed light on the intrinsic nature of the HO state.

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EXPERIMENTAL REPORT

Neutron powder diffraction (NPD) data were collected at the D20 diffractometer down to ~0.45 K. In order to highlight the magnetic scattering contribution, difference patterns were obtained by subtracting the pattern collected at higher temperature in the paramagnetic state, from data collected at 0.45 K (where magnetic ordering occurs). In this way, the resulting difference patterns consists of purely magnetic Bragg peaks.

As a result, faint magnetic peaks were highlighted. Unfortunately, it is not possible to index these peaks in any way with the cell parameters of $YbPd_2In$. These peaks can be in fact ascribed to the antiferromagnetic structure of $YbPd_3$, with magnetic propagation wavevector **k**=(1½,½,½). As a matter of fact, $YbPd_3$ occurs in very faint amounts as a secondary phase. Figure 1 shows the Rietveld refinement plot obtained for these NPD data (difference plot) and the magnetic structure characterizing the Yb sub-structure in $YbPd_3$.

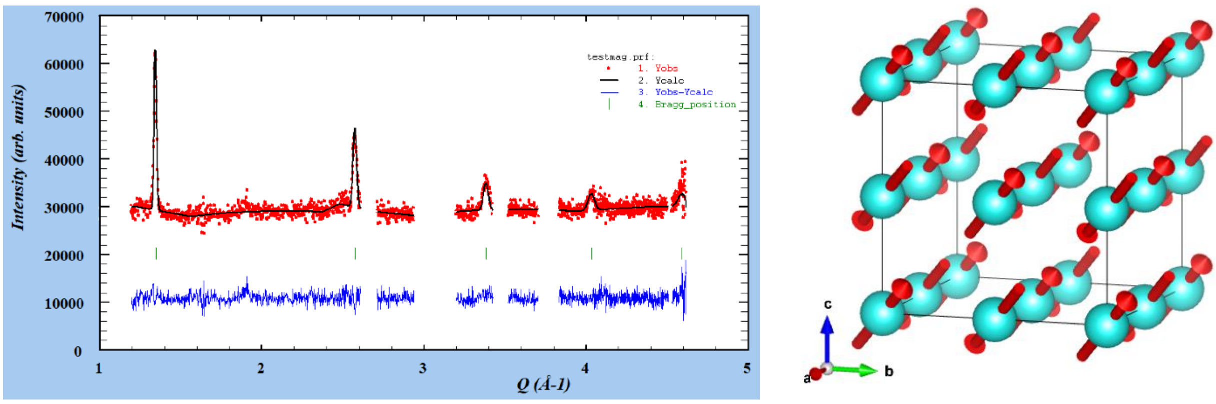

Figure 1. On the left: Rietveld refinement plot obtained using data collected at D20 (NPD data; difference plot). On the right: the magnetic structure characterizing the Yb sub-structure in $YbPd_3$.

Nonetheless, an evident bump determined by short-range magnetic interactions is observed in the NPD data (Figure 2, arrowed).

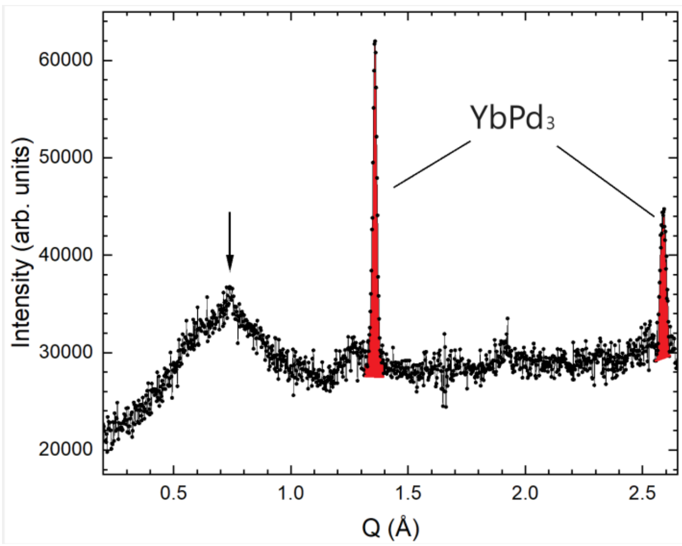

Figure 2. NPD data (difference plot) evidencing a clear bump at low Q-values (arrowed) indicating the occurrence of short-ranged magnetic interactions. Red-painted peaks are originated by the magnetic ordering of the secondary $YbPd_3$ phase.

In conclusion, no long range magnetic order attributable to $YbPd_2In$ can be detected. Nonetheless, short-ranged magnetic correlations are observed and would merit further investigation for determining their nature.