Experimental Report

Proposal: **4-01-1315** **Council:** 10/2012

Title: CePt4Ge12: Intermediate Valence ortrue Kondo system ?

This proposal is a new proposal

Researh Area: Physics

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Samples: LaPt4Ge12
CePt4Ge12

Instrument	Req. Days	All. Days	From	To
IN4	6	6	21/05/2013	27/05/2013

Abstract:

Rare-earth filled skutterudites exhibit a large variety of topical magnetic and electrical properties. Very recently skutterudites with chemical formula REPt4Ge12 have been synthesized [1]. They crystallize in the body-centered cubic, Im-3, structure. Detailed macroscopic measurements performed on the CePt4Ge12 let suppose that this compound is at the border between an intermediate valence (IV) and a Kondo lattice behavior. Its magnetic susceptibility shows a wide bump around 75-80 K, as typically observed in IV systems. However the value of the Kadowaki and Woods ratio is closer to what is expected for transition metals, than those reported in heavy-fermion systems. This makes the case of CePt4Ge12 very intriguing. In order to discriminate between IV or Kondo lattice behavior in CePt4Ge12, we propose a study by inelastic neutron scattering. This technique is very powerful to study such systems.

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Title : $CePt_4Ge_{12}$: Intermediate Valence or true Kondo system ?

The rare earth (R) filled clathrates are attracting an increasing interest for thermoelectric applications. Among them and in a more fundamental physics aspect rare earth filled clathrates form a fascinating class of new magnetic materials, in which the lanthanide element is weakly bound to its crystallographic site inside an oversized cage. New rare earth filled skutterudites with chemical formula RPt_4Ge_{12} have been synthesized very recently [1]. The very first detailed macroscopic measurements on the $CePt_4Ge_{12}$ concluded that this compound is at the border between an intermediate valence (IV) and a Kondo lattice behaviour [2]. High energy resolution XANES observations at the Ce L_{III} absorption edge are apparently consistent with a valence of the Ce ion close to three, while magnetic measurements reveal a very weak magnetic susceptibility that shows a wide bump around 75-80 K as typically observed in IV systems.

In order to discriminate between intermediate valence or Kondo lattice behaviour of the filled skutterudite compound $CePt_4Ge_{12}$ we have undertaken a very first inelastic neutron scattering study on the time-of-flight spectrometer IN4. The experiments have been performed from 21/05/2013 to 27/05/2013 at ILL on the Ce compound and the $LaPt_4Ge_{12}$ non-magnetic isomorphous.

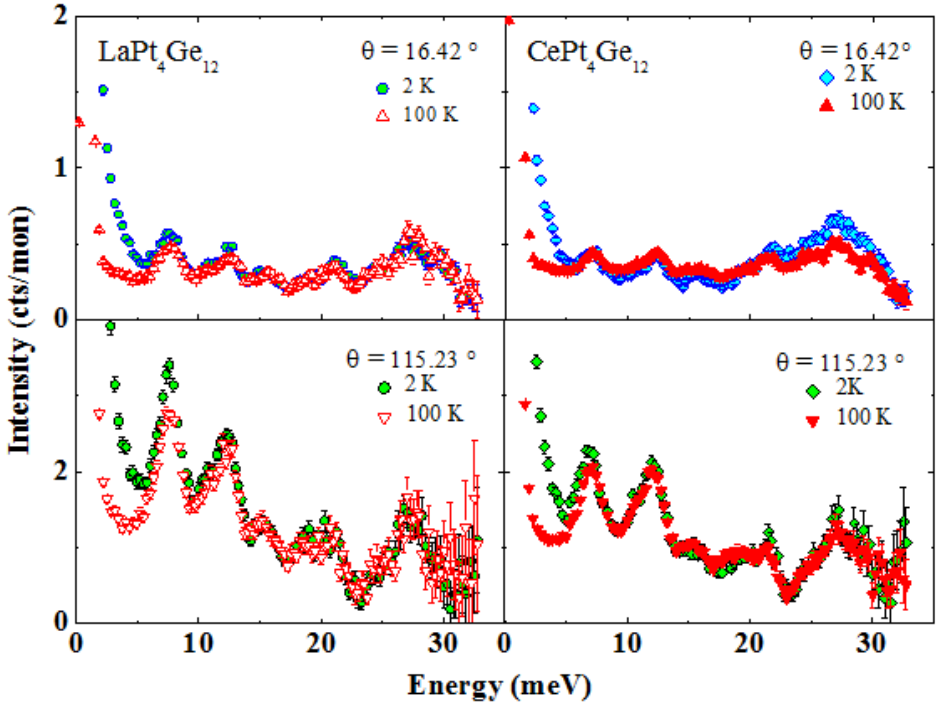

Fig. 1: Bose factor corrected inelastic response of $LaPt_4Ge_{12}$ and $CePt_4Ge_{12}$

The experiments have been performed with an incident energy wave length of 1.5 Å. Fig. 1 compares the Bose factor corrected inelastic responses at 2 and 100 K in the non-magnetic $LaPt_4Ge_{12}$ and $CePt_4Ge_{12}$ respectively. This comparison clearly demonstrate that in both compounds the inelatic signal is dominated by the phonon contribution with very similar features.

The spectra of the Ce compound show no evidence of normal crystalline electric field excitation. One just observes in the energy range 20-30 meV and at low angles an excess of signal at 2 K compared with the signal at 100 K. This preliminary INS results on $CePt_4Ge_{12}$ confirm a very anomalous behaviour of the Ce. This could be consistent with a IV behaviour but requires to be confirmed by further studies: study of the thermal evolution of the quasielastic neutron scattering and/or inelastic neutron scattering with polarized neutrons.

Quite recently Mohamed Zbiri started ab initio simulations of the GDOS in LaPt4Ge12. The very preliminary results show that the main contribution to the first phonon peak around 7 meV is due to the La.