Experimental Report

Proposal: **5-42-298** **Council:** 10/2011

Title: Short-range magnetic correlations in geometrically frustrated CePdAl

This proposal is continuation of: 5-41-603

Researh Area: Physics

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Samples: CePdAl

Instrument	Req. Days	All. Days	From	To
D7	5	5	25/10/2012	30/10/2012

Abstract:

Geometrically frustrated CePdAl orders antiferromagnetically below 2.7 K in an incommensurate structure. Doping Ni on the Pd site lowers in Ce(Pd,Ni)Al the ordering temperature and for a Ni content of 0.14 the transition is fully suppressed and a quantum phase transition approached with unusual low temperature properties. In a previous experiment on the parent compound CePdAl on D10 we established that 2/3 of the cerium moments exhibit long-range antiferromagnetic order, while 1/3 of the cerium moments show only short-range correlations. These short-range correlations show some peculiar temperature dependence. We want to study the momentum space dependence of these correlations and look for possible anisotropies. We ask for 5 days of beamtime on the instrument D7 to record intensity maps of reciprocal space to address our questions about the spin correlations in the frustrated heavy-fermion compound CePdAl.

CePdAl is a hexagonal heavy-fermion compound which orders antiferromagnetically below $T_{\mathrm{N}} = 2.7\,\mathrm{K}$ in an incommensurate structure with a propagation vector $k = (0.5\,0\,\tau)$, $\tau \approx 0.35$. The Kagome-like arrangement of the magnetic cerium atoms leads to geometric frustration and results in $2/3$ of the Ce moments being long-range ordered (LRO) while $1/3$ of the moments remain disordered. Recently we performed a single-crystal neutron diffraction experiment on D10 (ILL experimental report 5-42-603) and could show that these $1/3$ disordered moments display short-range magnetic order (SRO) below T_{N}. The aim of the present experiment was to study the momentum dependence of the spin correlations and look in particular for a possible spatial anisotropy of the SRO signal (basal ab plane versus c axis) in CePdAl.

Therefore, we carried out neutron diffraction on the diffuse scattering spectrometer D7 at the ILL, Grenoble. We recorded maps of the $(H0L)$-plane of a CePdAl single crystal with a mass $m = 1.89\,\mathrm{g}$ with full polarization analysis. Data were taken at temperatures between $T = 1.5$ and $300\,\mathrm{K}$ for two detector-bank positions to improve spatial resolution and an incident neutron wavelength $\lambda = 3.12\,\mathring{A}$. Additionally, measurements of quartz, vanadium and empty can were performed for polarization correction, for calibration of detector efficiencies and for background subtraction, respectively.

Fig. 1 and 2 show cuts along $(0.5\ 0\ L)$ and $(H\ 0\ 0.35)$ through the data at different temperatures with polarization in z-direction and for spin-flip scattering. All signal visible is of magnetic origin. In addition to sharp LRO peaks at the known magnetic positions, broad diffuse scattering is detected being more pronounced in the paramagnetic regime above T_{N}. The broad diffuse magnetic scattering above T_{N} follows the behavior for an Ising system with the c axis being the easy axis as expected for the Ising antiferromagnet CePdAl. Around the LRO peaks the tails due to the SRO are hardly visible most likely because the correlation length of the SRO is larger than what can be easily resolved on D7. Higher momentum resolution is required to study the SRO peaks and their relation to the LRO peaks at low temperatures in more detail.

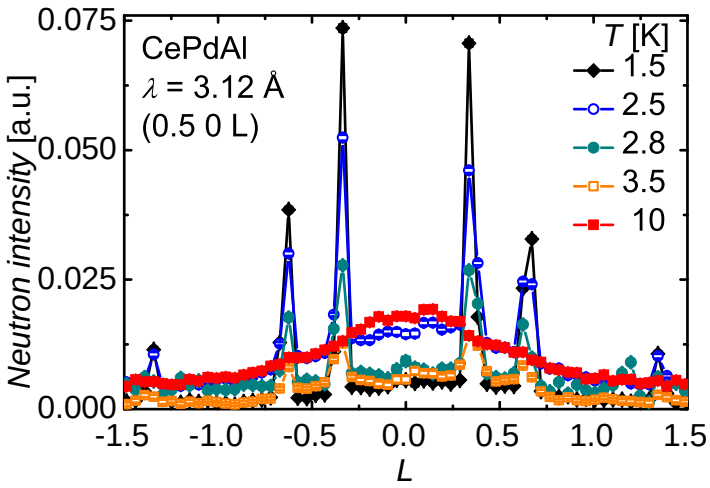

Fig. 1: Scans along $(0.5\ 0\ L)$ in CePdAl measured at different temperatures for neutron polarization along z and spin-flip scattering.

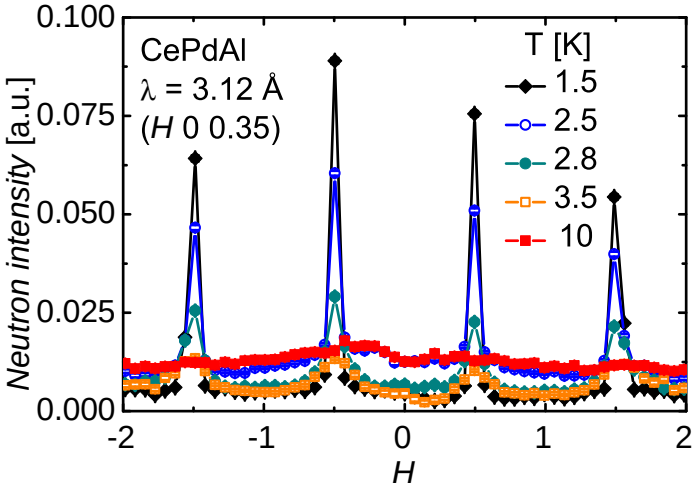

Fig. 2: Scans along $(H\ 0\ 0.35)$ in CePdAl for temperatures $T = 1.5 - 10\,\mathrm{K}$, neutron polarization along z and spin-flip scattering.