Experimental report

11/01/2016

Proposal: 4-01-1252 **Council:** 10/2012

Title: Magnetic field dependence of the resonance peak of the unconventionalsuperconductor CeCoIn5

Research area: Physics

This proposal is a continuation of 4-01-1060

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Samples: CeCoIn5

Instrument	Requested days	Allocated days	From	To
IN14	7	7	01/07/2013	08/07/2013

Abstract:

The spin resonance is an ubiquitous magnetic excitation appearing in many unconventional superconductors. Heavy fermion systems are particularly well suited to study the spin resonance under magnetic field since large effects can be observed due to the intrinsic low energy scales.

In a previous experiment, we establish by using polarized inelastic neutron scattering under horizontal magnetic field that the lineshape of the resonance mode of CeCoIn5 is polarization dependent. By separating the signal into chiral and non chiral contributions, we interpret our measurements as an evidence for the spin resonance being a degenerate mode with three fluctuations channels. This was established by performing measurements at 2 T ; we now want to study the field dependence of the different split branches especially owing to the fact that we found coincidence in energy between the lower mode of the Zeeman split peak and the longitudinal mode.

The spin resonance is characteristic of the magnetic excitation spectrum of unconventional superconductors. We have been performing a very detailed study of this excitation in the model system $CeCoIn_5$.

In a previous experiment [1], we performed a "half-polarized" (the initial neutron beam is polarized, the final polarization is not analyzed) INS experiment under a horizontal magnetic field applied on the sample. At 2 T, we found that the resonance lineshape depends on the neutron polarization measured in σ^+ or σ^- channel. Some of the spectral weight is common to the two polarization channels while the remaining part is distributed equally between them. We interpreted this as an evidence for the spin resonance being a degenerate mode with three fluctuations channels: A Zeeman split contribution and an additional longitudinal mode. This conclusion is drawn from the fact that the Zeeman split component is recognized by its chiral nature with such an experimental setup and a longitudinal mode has no chiral signature. Surprisingly, we found that the energy of the longitudinal mode is near the one of the lowest branch of the Zeeman split contribution. Our results were obtained for a unique field of 2 T while at 1 T there is no sizeable peaks separation.

The aim of the present experiment was to continue this investigation of the spin resonance of $CeCoIn_5$ for higher magnetic field (typically 3-4 T) in order to better investigate the surprising coincidence in energy between the longitudinal and the lower Zeeman split branch and to know how the spectral weight of the different contributions evolve with increasing magnetic field. The data obtained at the maximum field of 3.5 T show the same behaviour than the ones already obtained at 2 T with a clear distinction between σ^+ and σ^- data (Figure 1) and a clear chiral contribution (Figure 2). A successful quantitative analysis is still to be done beyond a phenomenological description and this must incorporate a new unexpected ingredient: the fluctuations at H=0 T have no chiral character [2] very much in line with what was observed at 1 T. This strongly suggests that a magnetic field evolution/change in the polarization pattern of the magnetic fluctuations must be considered.

[1] S. Raymond, K. Kaneko, A. Hiess, P. Steffens and G. Lapertot PRL 109 (2012) 237210.

[2] S. Raymond and G. Lapertot, PRL 115 (2015) 037001.

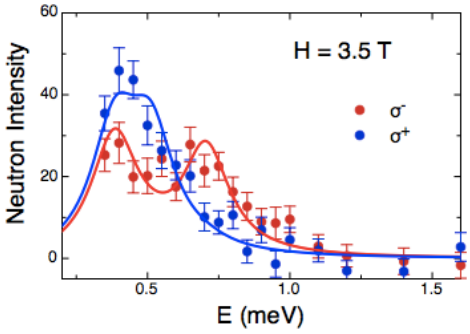

Figure 1 : Background subtracted data obtained in each polarization channel at 3.5 T for Q=(0.5,0.5,0.5) at T=50 mK.

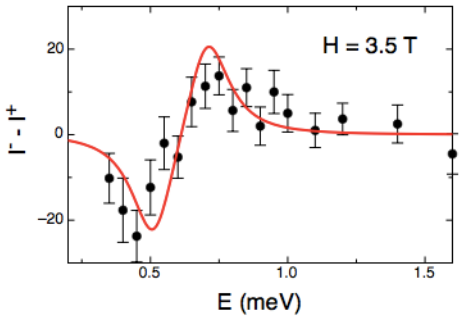

Figure 2 : Chiral signal corresponding to the subtracted data obtained in Figure 1.