Experimental Report

Proposal: **4-01-1340** **Council:** 4/2014

Title: Spin fluctuations in Hg doped CeCoIn5 with long-range commensurate magnetic order and superconductivity

This proposal is a new proposal

Researh Area: Physics

Main proposer: **STOCK Chris**

Experimental Team: STOCK Chris
SCHMALZL Karin

Local Contact: SCHMALZL Karin

Samples: CeCoIn4.95Hg0.05

Instrument	Req. Days	All. Days	From	To
IN12	10	8	20/04/2015	28/04/2015

Abstract:

The proposal requests time to measure the spin fluctuations in magnetically ordered CeCoIn5 doped with 5% Hg. Doping with Hg, suppresses superconductivity and enhances commensurate (1/2,1/2,1/2) magnetic order. Measuring the momentum and energy dependence of these fluctuations will help to understand the parent phase which competes with the unconventional superconducting phase in this material.

Simultaneous suppression of longitudinal fluctuations and superconductivity in Hg doped $CeCoIn_5$:

Abstract: The goal of the experiment was study the spin fluctuations in $CeCoIn_5$ in the case of Hg doping. Hg doping has the effect of inducing collinear antiferromagnetism and suppressing superconductivity. The sample studied had a concentration of 7% with a Neel transition of 3.5 K and a lower superconducting transition of 1.3 K (note that pure $CeCoIn_5$ has a transition temperature of 2.3 K). The experiment found that commensurate longitudinal fluctuations are suppressed in the antiferromagnetism state and also along with the resonance peak and superconductivity. These results point towards longitudinal fluctuations being important for the formation of superconductivity.

Experiment set up and outline: The experiment involved the coalignment of several hundred samples as done previously in the pure compound by the proposal team and others. The experiment started with k_f=1.3 A^{-1} and found a broad peak centered at the commensurate (1/2,1/2,1/2) position. An investigation of the temperature dependence and also A3 scans found this peak to spurious and the result of a strong background line at the elastic line feeding through into the inelastic channel. While the origins of this background are still unknown, it was found to be suppressed using k_f=1.25 A^{-1} where the rest of the experiment was performed. We note that the new He3 system worked well allowing access to temperatures between 0.5 K and 18 K.

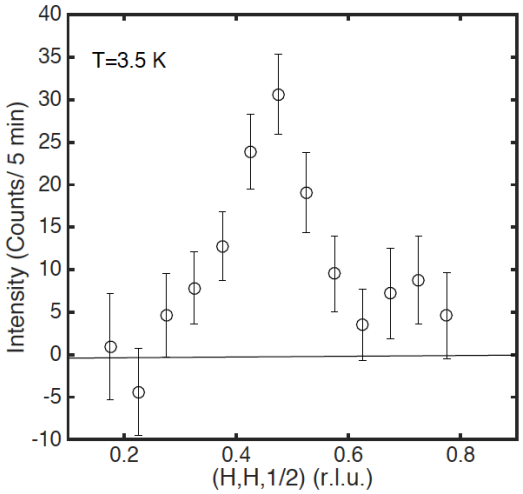

Figure 1: An scan through the correlated elastic scattering near H=0.5 at 0.5 meV. The spectral weight is suppressed in the Neel and superconducting states

We observed commensurate c-axis polarized fluctuations above T_N which disappeared at 20 K. These fluctuations were found to be suppressed below T_N and also in the superconducting state. Searches for transverse fluctuations at large L values failed to find any evidence for transverse spin-waves. This is a similar result to the pure $CeCoIn_5$ system and remains an open question as to why transverse fluctuations are present in $CeRhIn_5$ [1], but not $CeCoIn_5$ [2] and its doped variants. We note that the results also differ from pure $CeCoIn_5$.

Conclusions: Mercury doping suppresses superconductivity in favour of static collinear c-axis polarized magnetism. Our experiment shows that the fluctuations are simultaneously suppressed demonstrating that they are key for the formation of a high temperature superconducting phase in this system.

Future plans: We plan to combine these inelastic results with previous diffraction work performed on D23 (showing commensurate magnetism and studying the critical properties) and to submit this work for publication.

References:

[1] C. Stock et al. Phys. Rev. Lett. 114, 247005 (2015)
[2] C. Stock *et al.* Phys. Rev. Lett. **100**, 087001 (2008).