Experimental report

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Proposal: 5-42-368 **Council:** 4/2014

Title: Q=0 ferromagnetic fluctuations in the vicinity of the critical pointsin URhGe.

Research area: Physics

This proposal is a new proposal

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Samples: URhGe

Instrument	Requested days	Allocated days	From	To
D33	4	4	24/06/2016	28/06/2016

Abstract:

We propose to investigate the spin dynamics of the ferromagnetic superconductor URhGe in the vicinity of a Tricritical Point (TCP) and Quantum Critical Points (QCP) induced under magnetic field. Field dependent inverse correlation length and energy width will be used to determine whether magnetic fluctuations could provide the paring mechanism for the unconventional superconductivity.

Q=0 ferromagnetic fluctuations in the vicinity of the critical points in URhGe.

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We report the Small-Angle Neutron Scattering measurements on single crystal of ferromagnetic superconductor URhGe performed on D33 instrument at ILL. Experiment 5-42-368.

PACS numbers:

I. EXPERIMENT

We have carried out our SANS measurements in a horizontal magnetic fields up to 12 T and at temperatures between 2 K and 25 K. The magnet was oriented parallel to the incident momentum. The measurements were performed at the wavelength of 4.8 $\AA$. The distance between the sample and the detector was 2.8 m and the collimation was set at 2.8 m.

II. THE SAMPLE

Our sample was a 186 mg single crystal cut from the D.A.S. growth #5, mounted on Al sample holder with the a-axis vertical and the b-axis parallel to the field and the neutron incident momentum, Figure 1. The sample was oriented with the backscattering X-ray Laue instrument at Edinburgh and checked with the neutron Laue using the ORIENT EXPRESS instrument at ILL, which confirmed its orientation and good crystallinity.

III. MEASUREMENTS IN 0 T.

Typically, each scan was collected over 30 minutes 3 times to obtain a good statistics. To obtain the scattering as a function of the wavevector, a reduction protocol was built and applied to the data. A sector average was chosen to isolate the signal at the top and the bottom sides only with the width $\Delta\phi$=60 degrees and with the radius of up to 0.1 $\AA^{-1}$. For the empty cell we have used the scans collected at T=25 K, well in the paramagnetic state of URhGe. The default mask was used to mask the direct beam.The measurements in the zero filed showed that the scattering appeared close to the Curie temperature, T_{Curie}=9.5 K and fell very sharply at temperatures above and just below T_{Curie}, FIG 2. The reduced data in the form of intensity as a function of the wavevector was fitted to the lorentzian lineshapes to extract the correlation length, FIG 3. The correlation length peaks strongly at T_{Curie}=9.5 K as expected.

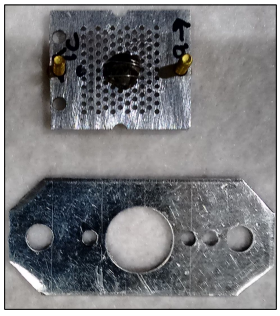

FIG. 1: Sample of URhGe mounted on a meshed Al sample holder (top). The a-axis was vertical, the c-axis horizontal, and the b-axis parallel to the neutron flux. The bottom Al plate was used to fix the sample holder to the "coldplate" of 17 T magnet. The brass screws and the platforms were covered by Cd foil to minimize a parasitic signal from Al and brass.

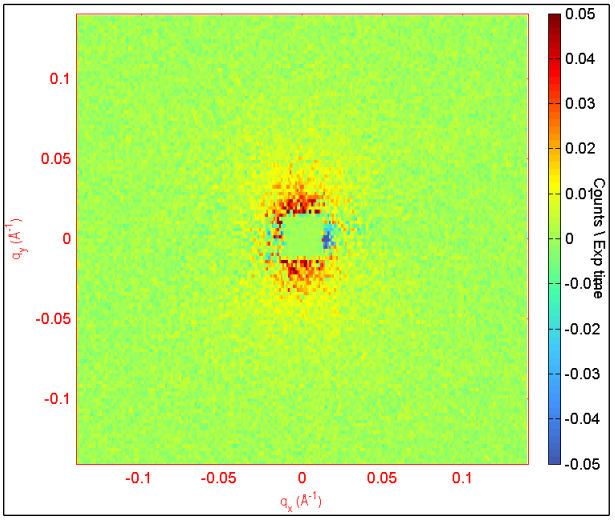

FIG. 2: Zero field SANS data taken at 9.5 K with 25 K data subtracted as a background. The increased scattering at the top and the bottom figure corresponds to the critical scattering and reflects the anisotropy of the ordered moment, which points along the c-axis.

IV. MEASUREMENTS IN FINITE FIELDS.

We have also performed the measurements in fields up to 12 T. In contrast to zero field measurements we did not find a

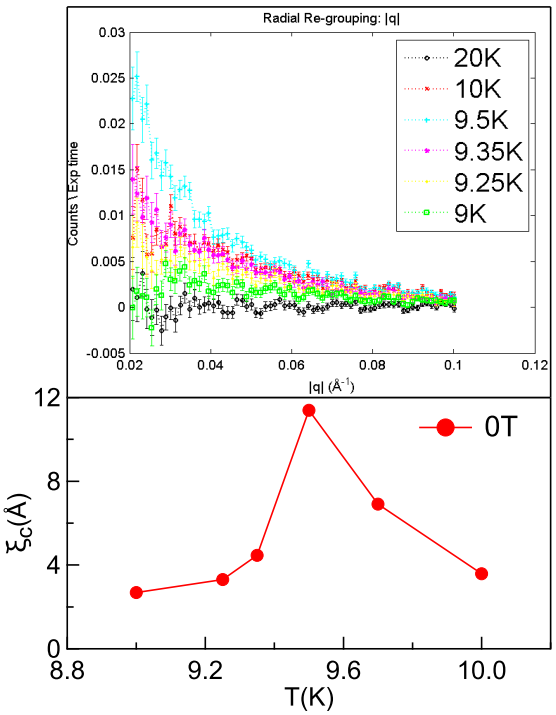

FIG. 3: (top)Intensity as a function of the wavevector at various temperatures close to T_{Curie} in zero field. (bottom) Temperature dependence of the correlation length in zero field.

temperature dependent signal at 11 T and 12 T, i.e. near the critical field at which the superconducting transition temperature is maximized. The scattering at T_{Curie}=9.5 K decreases strongly already at the modest field of 1 T, in contrast to the field-temperature phase diagram, which shows that T_{Curie} is relatively field independent below 8 T. We also note that according to the neutron diffraction results the ordered moment rotates parallel to the field at 8 T, which means that in our experimental geometry we are sensitive to both a and c components of the fluctuating moment. However, we did not observe the magnetic scattering at the critical field of 11-12 T at temperatures above 1.5 K.

V. CONCLUSION

This finding suggests that the fluctuations transverse to the ordered moment are suppressed by the magnetic field and not enhanced as we had anticipated[1].

Acknowledgments

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[1] V. P. Mineev, Physical Review B, **91**, 014506 (2015).