Experimental report

15/10/2019

Proposal: 5-32-867 **Council:** 10/2018

Title: Origin of diffuse signal in UIrSi3

Research area: Physics

This proposal is a new proposal

Main proposer: Jaroslav VALENTA

Experimental team: Milan KLICPERA
Jaroslav VALENTA
Petr CERMAK

Local contacts: Andrew WILDES

Samples: UIrSi3

Instrument	Requested days	Allocated days	From	To
D7	5	4	11/07/2019	15/07/2019

Abstract:

RTX3 compounds crystallizing in the non-centrosymmetric BaNiSn3-type structure reveal frequently diverse and exotic physical properties. UIrSi3 is one of the only two UTX3 isostructural analogs. Contrary to rare-earth-based compounds with localized 4f electrons, the physical properties of UTX3 origin in the 5f-electron wave functions losing, to an extent, their atomic character due to mutual overlap between neighboring U ions and hybridization of 5f states with valence-electron states of ligands. A complex magnetic phase diagram and most probably a complex magnetic structure make UIrSi3 a prominent system for detailed microscopic investigations. Besides intensive investigations of macroscopic properties, we performed neutron diffraction experiments on CYCLOPS and D10. Our recent data strongly suggest the presence of rather anisotropic diffuse scattering signal beneath the nuclear reflections. The origin of diffuse signal might be found in local atomic defects of ordered lattice, which seem to cause partial anisotropic magnetic disorder at low temperatures.Proposed experiment on D7 aims to investigate the observed diffuse signal in detail – to separate its individual contributions.

Origin of the diffuse signal in $UIrSi_3$

We performed an experiment of powdered $UIrSi_3$ sample on D7 spectrometer in diffraction mode (XYZ polarization analysis).

$UIrSi_3$ compound crystalizes in non-centrosymmetric tetragonal structure of $BaNiSn_3$-type. It orders antiferromagnetically below $T_N = 41.7$ K and undergoes magnetic field induced metamagnetic transition ($\mu_0 H_c = 7.3$ T at 2 K) for magnetic field applied along tetragonal *c*-axis. The metamagnetic transition (MT) is first-order phase transition with asymmetric field hysteresis at temperature up to ~ 28 K. Above this so called trictricital point a second-order magnetic phase transition is identified [1].

Recent neutron diffraction experiments on CYCLOPS and D10 diffractometers brought an evidence of antiferromagnetic ordering in $UIrSi_3$ with single propagation vector $\boldsymbol{k}$ = (0.1, 0.1, 0). The experiment pointed to temperature evolution of diffuse scattering around nuclear reflections. Origin of the diffuse scattering was the main question addressed to neutrons for this experiment on D7.

The experiments confirms diffuse signal origins from nuclear disorder which increased above 35 K rapidly and from 150 K becomes nearly constant (see in fig. 1). On the other hand, magnetic part shows no contribution into diffusion signal and only one magnetic reflection has been observed around 10° of 2θ (see in fig. 2).

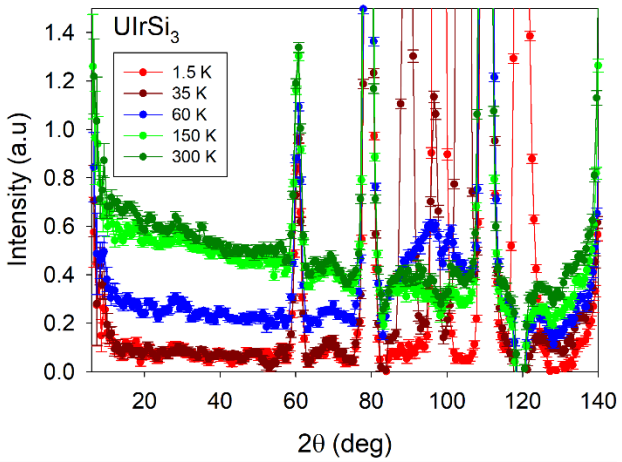

Fig. 1 – Nuclear part of diffraction pattern measured at several different temperatures.

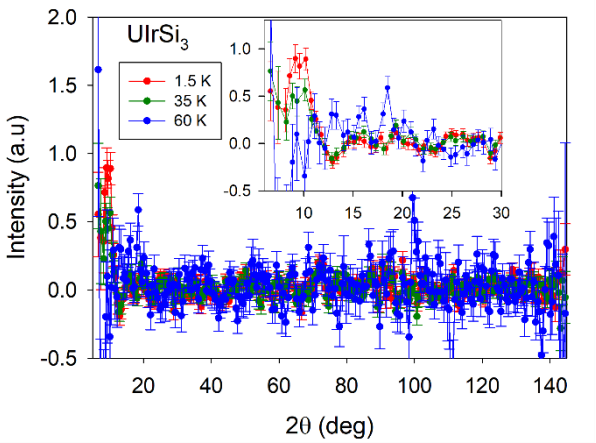

Fig. 2 – Magnetic part of diffraction pattern measured at several different temperatures.

The experiment brings unexpected findings in observation of nuclear reflections which can not be describe by tetragonal $BaNiSn_3$–type structure. As is shown in fig. 3, new reflections arise below 60 K which is still above magnetic phase transition (41.7 K). Below 35 K is observed other set of new reflections. The reflections origins from tetragonal $BaNiSn_3$ structure are present in all temperature range.

[1] J. Valenta, F. Honda, et al., Phys. Rev. B 97, 144423 (2018).

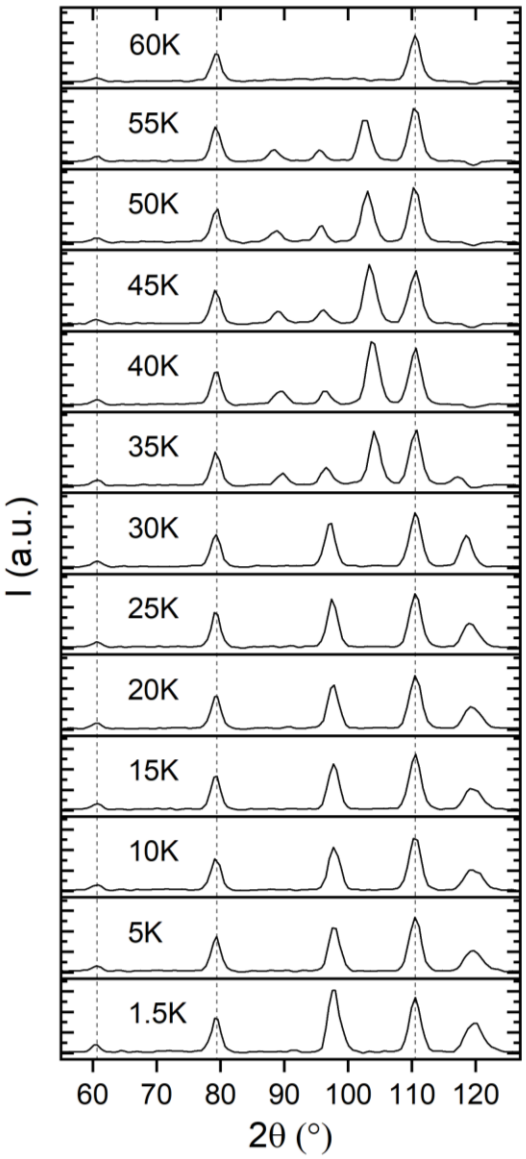

Fig. 2: Nuclear reflections of $UIrSi_3$ compound measured on D7 for several different temperatures. Dash lines marks reflections belongings to BaNiSn3-type structure.