ABSTRACT CODE

On the magnetic structure of UIrGe

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Uranium compounds exhibit a wide range of interesting electronic properties, such as itinerant or localized magnetic moment, spin fluctuations, heavy-fermion and non-Fermi liquid behavior, superconductivity, and complex short-range or long-range magnetic correlations. [1].

UIrGe represents one of the most puzzling cases among orthorhombic UTX (T = transition metal and X = Si or Ge) compounds despite of considerable effort over last 15 years or so [1-3]. All bulk properties point to an antiferromagnetic (AF) ordering below 16-18 K [1]. These include anomaly in the temperature dependence of magnetic susceptibility, specific heat and a dramatic resistivity change at T_N which has, however, different sign on a polycrystalline and single-crystalline material [4]. Despite several neutron diffraction experiments of several research groups on powders [5-6] and single crystals [7], no signal that could be assigned to magnetic ordering was detected although the muon spin rotation spectroscopy on a powder suggests that UIrGe orders magnetically [8]. Here we report on neutron diffraction studies of newly grown UIrGe single crystal in magnetic fields up to 14.5 T.

UIrGe single crystal has been grown from a stoichiometric melt by a modified Czochralski method in a gettered purified Ar atmosphere. EEPMA analysis revealed a small (less than 2 vol.%) amount of UIr impurity phase.

Crystal has been oriented by a Laue X-ray technique, glued on an Al tip and investigated at the double-axis E4 and multicounter E6 diffractometers, both installed at the Berliner Neutron Scattering Center (BENSC) at HMI. The neutron wavelength was in both cases 2.44 Å. In the case of E6 we used a standard orange cryostat, in the case of E4 studies the crystal was inserted into a superconducting magnet capable to generate vertical magnetic field of up to 14.5 T.

On E6, which provide higher neutron flux, we have found a weak signal to develop on top of the (201) reflection below 17 K, i.e. below temperature that agrees rather well with the magnetic phase transition for this crystal [4]. With this knowledge we have performed extensive search for magnetic signal in zero field and in fields up to 14.5 T on E4. However, no other magnetic signal that would be larger than associated statistical error has been found so far. So, we are left with only one clear observation at the moment.

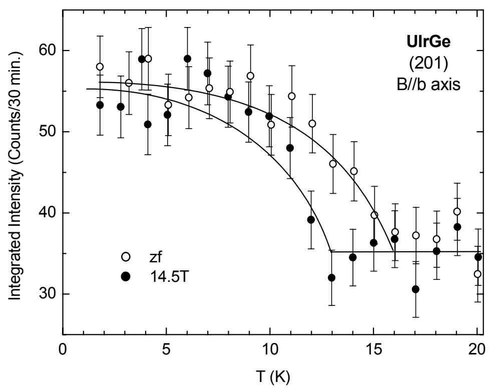

Fig.1: Temperature dependence of the integrated intensity of the (201) reflection measured on E4

As can be seen from Figs. 1 and 2, even 14.5 T applied at 1.8 K along the b axis is not sufficient to induce in UIrGe a forced ferromagnetic order. This is in agreement with magnetic phase diagram determined bulk measurements, which is shown in Fig. 3 [9] although above 12.5 T one expects another type of order than at low fields.

Supposing that the propagation vector of the expected antiferromagnetic structure is ***q*** = (0 0 0) one can construct possible magnetic structures. The symmetry analysis allows U moments to be aligned in a AF or F manner along the b axis or within the a-c plane (see Table 1). These are the same structures as are allowed for ferromagnetic URhGe [10] or for field-induced magnetic structure of UNiGe [11]. Surely, from one reflection it is rather uncertain to refine the magnetic structure. However, among all the possible structures there is only one that gives significant intensity on the (201) reflection and much smaller intensities on other 23 inequivalent

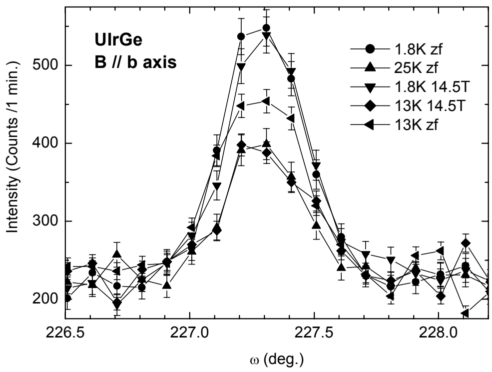

Fig.2: (201) reflection measured at E4 at various thermodynamic conditions.

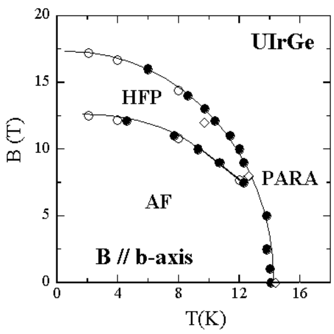

Fig.3: UIrGe b axis magnetic phase diagram

measured reflections. This structure, which is listed in Tab. 1 as Γ_2, allows for AF a axis and c axis component. Full refinement of the structure (of both components) to (102), (203), (302), (401) and (201) reflections (the first four of them have the statistical error

Table 1: Possible magnetic structures for the four U moments in position 4c in Pnma and q = (0 0 0).

I.R.	Magnetic moment components		
	x	y	z
Γ_1		+ + − −	
Γ_2	+ − − +		+ − + −
Γ_3		+ + + +	
Γ_4	+ − + −		+ − − +
Γ_5	+ + + +		+ + − −
Γ_6		+ − + −	
Γ_7	+ + − −		+ + + +
Γ_8		+ − − +	

larger than the actual suspected magnetic intensity) leads to an unreasonable high a axis component (0.7 μ_B). However, single component refinement leads to AF c axis component of 0.09±0.02 μ_B/U. For comparison, the high-field magnetization measurements reveal an increase of 0.2 μ_B at the metamagnetic-like transition. To resolve the structure in detail, other orientations have to be investigated and few unclear points clarified - for instance, the origin of some (h/3 0 l/3) reflections that are visible independently of field and temperature.

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