ESRF	**Experiment title:** A Resonant X-ray Scattering Study of $NpRhGa_5$	**Experiment number**: HE1828
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An X-ray resonant scattering study (XRS) of $NpRhGa_5$ was done in order to study its magnetic structure and to get an indirect information on the hybridization of the Np 5*f* and Ga 4*p* electronic states which play a crucial role in the formation of various magnetic structures within the actinide 115 compound series [1,2].

$NpRhGa_5$ orders magnetically below T_N = 36.5 K and it undergoes another magnetic phase transition at T^* = 32.5 K [3]. Recent neutron diffraction study [4] shows that Np atoms order antiferromagnetically (AF) with propagation vector $\boldsymbol{q}$ = (0, 0, ½) in both ordered phases. The magnetic structure can be described by ferromagnetic coupling of the magnetic moments in the basal plane and AF stacking along the *c*-axis. In the high-temperature ordered phase ($T^*<T<T_N$) the Np magnetic moments are oriented along the *c*-axis and T^* corresponds to their reorientation into the *ab*-plane ($\boldsymbol{m}_{Np}$ || [110]); also the magnitude of the moment changes [4].

In the present experiment, the incident photon energy was tuned to the resonance on the Ga K-edge (10.365 keV). Large signal, solely in the σπ channel, was observed. Its temperature dependence (see Fig. 1) shows that it follows the behaviour observed previously on Np: magnetic moment reorientation at T^* with a change of moment amplitude. Its azimuthal dependence suggests that it arises from a symmetry breaking “magnetic dipole” vector.

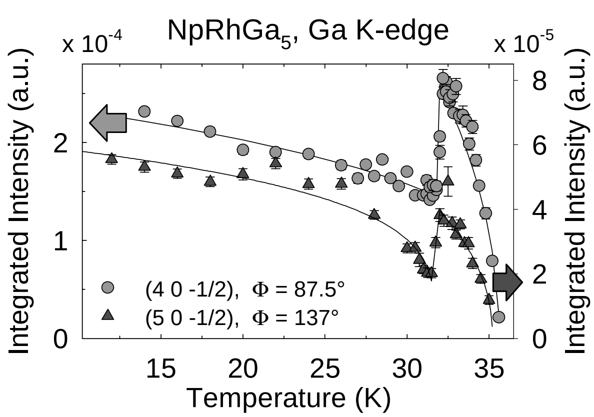

Fig. 1: Temperature dependence of Ga K-edge signal for two different magnetic diffraction vectors. Azimuth (Φ) for both scans chosen so that the magnetic moment reorientation at T^* (~ 32 K) is well visible.

We suggest that it is an orbital polarization of the Ga 4*p* states induced through strong hybridization with Np 5*f* valence level. Our data thus provide indirect information about the hybridization and theoretical efforts to understand the data are in progress.

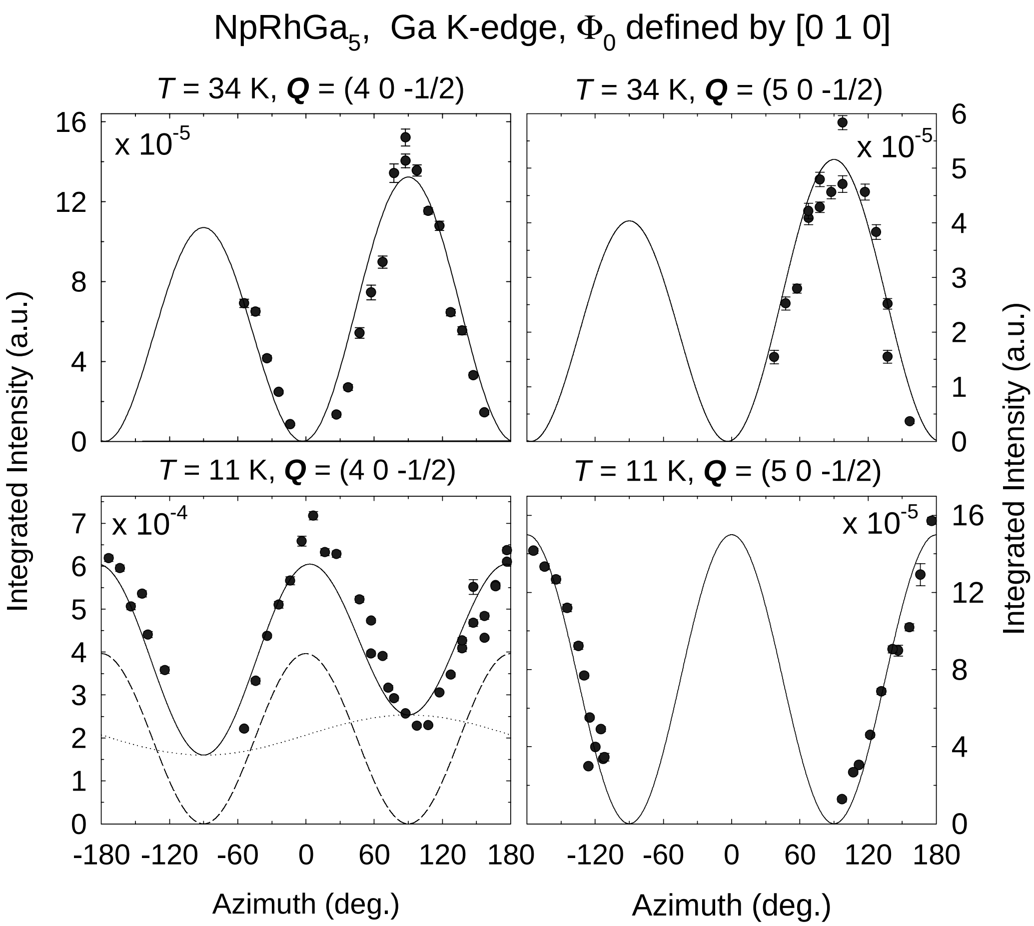

Fig. 2: Azimuthal dependence of scattering in the two different phases. The high-temperature data (upper plots) are well explained by the orbital polarization at the Ga site directed along the *c*-axis. In the low-temperature state, when the Np moments are in the basal plane, the vector at Ga_I (deduced from the right-hand plot) appears to be directed along the *b* axis, whereas the Ga_I and Ga_{II} signals (left-hand panel) require some component away from the *b* axis as indicated by the *a* and *b* axis models given by dotted and broken lines. The full line corresponds to the sum of the two contributions.

Fig. 2 shows our experimental data recorded in the two ordered phases. Resonance at different scattering vectors was investigated in order to distinguish between contributions from two crystallographically (and possibly also magnetically) inequivalent Ga sites, Ga_I and Ga_{II}. Two lower panels show data in the $T^* < T < T_N$ phase. Very good agreement with a model of *c*-axis dipole was found for both Ga sites (full line in the two lower plots in Fig.2). In the low-temperature phase ($T < T^*$) the situation is more complex. At the scattering vector **Q** = (5 0 -½) only Ga_I contribute to the signal. These data can be best fitted by a model assuming Ga "moment" || *b**-axis whereas at **Q** = (4 0 -½) (contribution from both Ga_I, Ga_{II}) also an *a*-axis component is present.

References

[1] N. Metoki, K. Kaneko, E. Colineau et al., Phys. Rev. B **72** (2005) 014460
[2] K. Kaneko, N. Metoki, N. Bernhoeft et al., Phys. Rev. B **68** (2003) 214419
[3] E. Colineau, F. Wastin, J. Rebizant, J.Phys.: Condens. Matter **18** (2006) 411
[4] S. Jonen, N. Metoki, F. Honda et al., submitted to Phys. Rev. B