ESRF	**Experiment title:** Resonant x-ray magnetic scattering from NpP (2 experiments of LTP)	Experiment number: *HE-818*
Beamline: ID20	**Dates of experiments**: from: 14 Feb 2001 to: 18 Feb 2001 18 April 2001 24 April 2001	**Date of report**: 11 Aug 2001
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Since NpP had been proposed from neutron experiments [1] to have antiferromagnetic structures of the single-**k**, double-**k**, and triple-**k** classes, we undertook experiments on ID20 to try to confirm this by observing new satellites in the diffraction pattern associated with the multi-**k** states. We did not observe these resonant magnetic satellites, which suggested that the commensurate magnetic structure of NpP is of the single-**k** class. We also found evidence for this type of magnetic structure by examining the interplay between the crystal symmetry and the Fourier components of the magnetic structure.

The high wave vector resolution intrinsic to synchrotron radiation has also proved to be important to obtain a complete picture of the NpP magnetic phase diagram. Fig. 1 shows reciprocal lattice scans along the [0, 0, L] direction about the (0, 0, 2+*k*) position as a function of temperature. The energy and polarization dependencies confirm that all the peaks shown in Fig. 1 are magnetic, and bulk properties. In agreement with Ref. 1, T_N is of the order of 130K. The initial ordering is incommensurate with the crystal lattice and persists down to about 70K until a first order transition occurs to a commensurate phase (*k*=1/3). The excellent wave vector resolution is especially useful when there are coexisting modulations and has revealed a "splitting" of the incommensurate satellite.

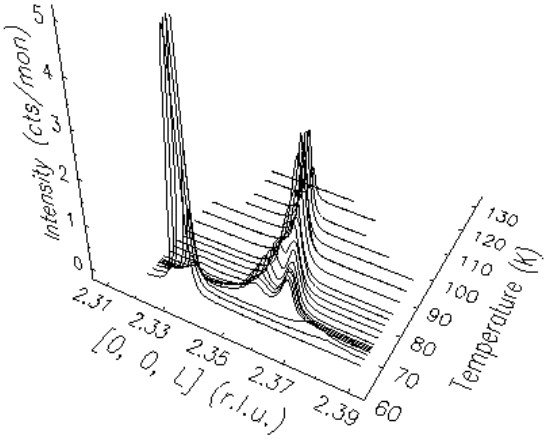
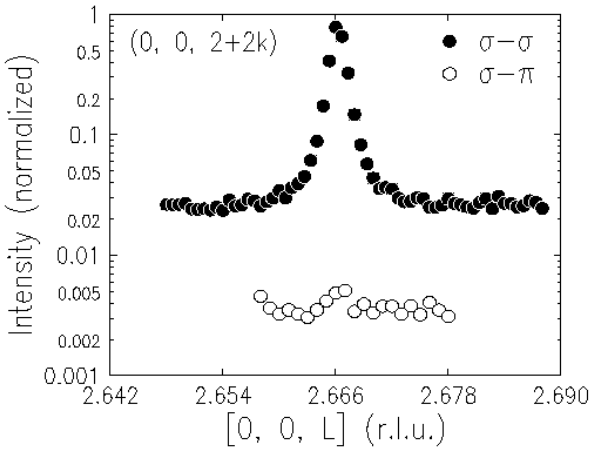


Figure 1
Reciprocal lattice scans about the (0, 0, 2+*k*) AF reflection of NpP as a function of temperature. The photon energy was fixed at the Np M_4 resonance.

Figure 2

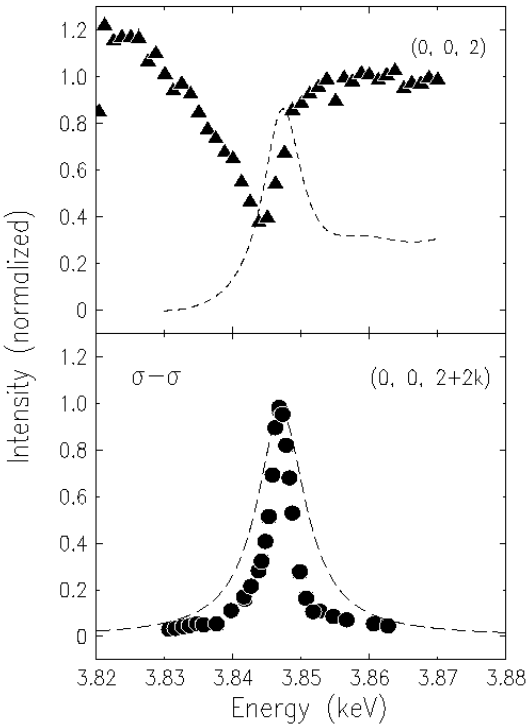
The normalized intensity of the (0, 0, 2+2*k*) charge modulation measured at the Np M_4 edge in the σ-π and σ-σ polarization channels (open and closed symbols, respectively).



Although we did not observe the $\mathbf{k}_i+\mathbf{k}_j$ satellites of a multi-**k** structure, we did observe a weak resonant satellite at 2*k*. See Fig. 2. Resonant magnetic harmonics have previously been reported at this position for the cycloid structure of UPtGe [2]. It was therefore important to establish whether or not our 2*k* harmonic was intrinsic to the resonant scattering process. Measurements of the polarization, energy, and temperature dependencies confirmed that the 2*k* peak is associated with a lattice harmonic, and not related to the magnetic resonant cross section confirming the single-**k** nature of the commensurate magnetic structure.

Figure 3

The energy dependence of (1) a lattice reflection (and the fluorescence spectrum shown by a dashed line) and (2) the 2*k* charge modulation. The energy dependence of the 2*k* modulation is much narrower than that of the antiferromagnetic resonance (dashed line).



The energy dependence of a lattice reflection and the charge harmonic are shown in Fig. 3. The 2*k* lattice harmonic is resonantly enhanced at the Np M_4 edge. We believe that this resonance is related to the two different lattice sites that the Np atoms occupy in this material. A publication of this experiment is now in draft stage, which includes an analysis of this effect.

[1] Aldred et al., Phys. Rev. B 9, 3766 (1974); Thesis of F. Bourdarot (1994)

[2] Mannix et al., Phys. Rev. B 62, 3801 (2000)