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Resonant x-ray scattering study of $PrRu_4P_{12}$

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$PrRu_4P_{12}$ exhibits a metal-insulator (MI) transition at $T_{\rm MI} \simeq 60$ K [1] associated with a structural phase transition with a modulation vector $\mathbf{q} = [1, 0, 0]$ [2]. A nesting of the Fermi surface at $2\mathbf{k}_{\rm F} = [1, 0, 0]$ suggested by a band-structure calculation induces formation of CDW which is crucial for the MI transition [3]. However $LaRu_4P_{12}$ does not show the MI transition although the nesting of the Fermi surface also suggested. This fact indicates that $4f$ electrons of Pr are indispensable for the MI transition. Here we report on a resonant x-ray scattering study of $PrRu_4P_{12}$ at Pr L_3-edge. The Pr $5d$ states, which are intermediate states of resonant process, are modified by the Pr $4f$ electrons through the Coulomb interaction and/or the lattice distortion.

Figures 1 show energy dependence of (313) and $(13\overline{1})$ reflections which are forbidden above $T_{\rm MI}$. These reflections contain two components. One is non-resonant component due to the lattice distortion, whose amplitude is independenet of the photon energy. The other is resonant scattering of Pr, which is enhanced near the absorption edge ($\sim$ 5.955 keV). The existence of the latter component is evdenced by abrupt changes in intensity near the absorption edge. Observed intensity is an interference between both terms, and the interference extends to higher energy beyond the absoption edge. Because the resonant term for odd number of $h + k + l$ corresponds to the difference of anomalous scattering factor between two Pr atoms in the *bcc* unit cell, our results suggest a spatial ordering of two different electronic state of Pr atoms.

[1] C. Sekine *et al.*, Phys. Rev. Lett. **79**, 3218 (1997). [2] C. H. Lee *et al.*, J. Phys. Condens. Matter **13**, L45 (2001). [3] H. Harima *et al.*, Physica B **312-313**, 843 (2002).

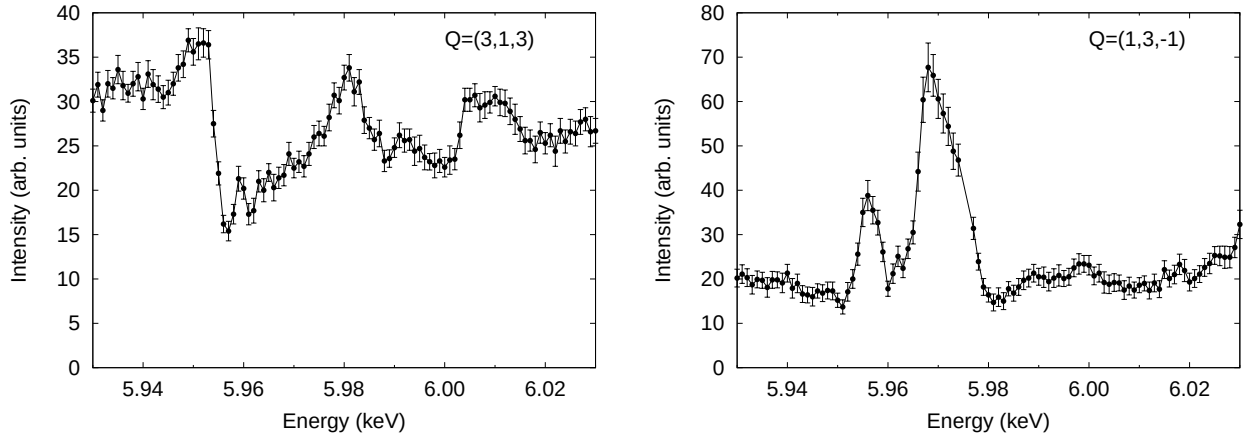

Figure 1: Energy dependence of superlattice reflections near the Pr L_3-edge. In addition to the non-resonant component due the lattice distortion, clear resonant features can be seen.