

## Strong Temperature Dependence of Magnetic Excitation on the Metal-Insulator Transition of $\text{PrRu}_4\text{P}_{12}$

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$\text{PrRu}_4\text{P}_{12}$  exhibits a metal-insulator (M-I) transition at  $T_{\text{M-I}} = 63$  K (C. Sekine *et al.*, Phys. Rev. Lett. 79 (1997) 3218). Electrical resistivity turns up below  $T_{\text{M-I}}$ , and X-ray diffraction studies revealed that the crystal structure transforms from bcc ( $\text{Im}\bar{3}$ ) to a simple cubic ( $\text{Pm}\bar{3}$ ) characterized by the wave vector  $\mathbf{q}_0 = \langle 1, 0, 0 \rangle$  below  $T_{\text{M-I}}$  (C. H. Lee *et al.*, JMMM 272-276 (2004) 426, L. Hao *et al.*, JMMM 272-276 (2004) e271). The band calculation study proposed the Fermi-surface nesting condition with  $\mathbf{q}_0$ , so that this phase transition is a formation of charge density wave (CDW) (H. Harima and K. Takegahara, Physica B 312-313 (2002) 843).

To investigate a 4f-electron state, we performed an inelastic neutron scattering experiments. Figure 1 represents typical measured response functions  $S(E)$ . Distinct peaks are attributed to crystal-field (CF) excitations. Because local environments around the Pr ions at the unit-cell origin and at the body center are different in the superlattice below  $T_{\text{M-I}}$ , the spectra are explained by two CF schemes. It is noticeable that with increasing temperature all the peaks shift to lower-energy side by about 3 meV. Moreover, they become very broad near  $T_{\text{M-I}}$ ; the half width at half maximum is 1.7 meV at 70 K. These observed phenomena can be explained by hybridization between 4f and conduction electrons. The CF excitation peaks evolve from the resolution-limited width in the less-carrier state at lower temperature to the very broad one in the dense carrier state at higher temperature. The CF-energy shift is explained by p-f mixing effect modifying the CF levels. Such drastic 4f-electron evolution takes a role in the CDW transition.

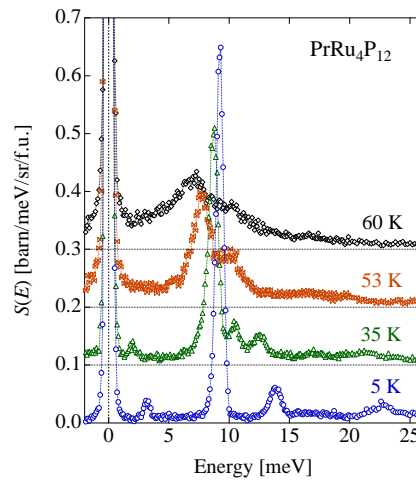


Figure 1: Left figure shows  $S(E)$  of  $\text{PrRu}_4\text{P}_{12}$  measured at LAM-D. Origins of vertical axes of each temperature are shifted by 0.1.