

Novel features associated with plural 4f-electrons in the filled skutterudites

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Almost every variety of attractive features have been found in the filled skutterudite compounds (RETr_4Pn_2 : R= rare earth, T= Fe, Ru, Os, and X= P, As, Sb), by replacing the constituent elements [1-4]. In order for such features to be realized, the strong c-f (conduction-4f electrons) hybridization caused by the unique crystal structure shown in Fig.1 (R ion is surrounded by twelve X and eight T ions) is indispensable. In fact, highly correlated electron phenomena have been confirmed even in the systems containing rare-earth elements with plural 4f-electrons, e.g., quite highly enhanced effective masses in $\text{PrFe}_4\text{Sb}_{12}$ and $\text{SmOs}_4\text{Sb}_{12}$. In most of the novel features, such as the metal-insulator transition

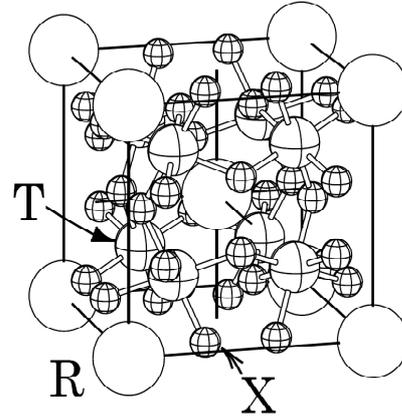


Fig.1 Filled skutterudite structure.

in $\text{PrRu}_4\text{P}_{12}$, the nonmagnetic ordered phase competing with heavy fermion (HF) state in $\text{PrFe}_4\text{P}_{12}$ and the HF superconductivity in $\text{PrOs}_4\text{Sb}_{12}$, some hidden parameters associated with 4f-electrons other than the ordinary magnetic dipole have been believed to play key roles.

Prior to the skutterudite research, “nonmagnetic ordered phase” found in several materials such as URu_2Si_2 has been one of the important subjects in the highly correlated electron systems. However, the progress to clarify the “hidden order parameter” is very slow, since the ways to identify the parameter are usually so limited. In the filled skutterudite family, there have been found many kind of “hidden ordered phases” which are intensively investigated by various experimental techniques; neutron scattering, NMR, ultrasonic attenuation, etc. Among them, the role played by the μSR technique is quite important which is powerful to identify the magnetic characteristics of hidden order parameter “multipole”. In the initial part of my talk, some of the novel features found in the filled skutterudite compounds will be introduced. Afterward, I would like to explain several examples which prove the effectiveness of the μSR technique.

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