

Optical conductivity and electronic structures of Ce-filled skutterudites

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We have been systematically measuring the optical conductivity spectra of various filled skutterudite compounds, in order to probe the variation of the electronic structures in these compounds. The compounds studied so far include CeRu₄P₁₂ [1], CeOs₄P₁₂, CeRu₄Sb₁₂ [2], CeOs₄Sb₁₂ [2,3], CeFe₄Sb₁₂ [2], PrRu₄P₁₂ [1,4,5], SmRu₄P₁₂ [4,5], PrFe₄P₁₂, and GdRu₄P₁₂ [6], among others. In this presentation we mainly discuss our results on the Ce-filled compounds.

Among the Ce-filled compounds, various experiments have shown that CeRu₄P₁₂ and CeOs₄P₁₂ are semiconductors with an energy gap of ~ 0.1 eV, and that CeRu₄Sb₁₂ has metallic characteristics. For CeOs₄Sb₁₂, the electrical resistivity shows a semiconductor-like increase at low temperatures, while thermal and magnetic measurement do not show a sign of an energy gap at the Fermi level. Our optical conductivity data show the following: (1) For CeRu₄P₁₂ and CeOs₄P₁₂, there is a large pseudogap of about 0.5 eV, which is much larger than the gap given by the transport measurements. (2) For CeRu₄Sb₁₂ and CeOs₄Sb₁₂, there is a pseudogap of about 0.1 eV around the Fermi level. The pseudogap is filled in quickly with increasing temperature, in a similar fashion to that seen for Kondo semiconductors. We will discuss the electronic structures suggested by our data in comparison with the above-mentioned results by other experiments, and also with the recent theoretical analysis on the optical conductivity of Ce-filled skutterudites [7]. We will also briefly discuss our results on GdRu₄P₁₂ [6], which is an antiferromagnet with $T_N=22$ K.

References

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