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Thermoelectric power and thermal transport of anomalous rare-earth Kondo compounds

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The thermoelectric power and the thermal conductivity have been well studied experimentally and theoretically in Cerium, Ytterbium or other anomalous rare-earth systems. Very large values of the thermoelectric power have been observed in compounds such as $CeAl_3$, $CeCu_2Si_2$ or $YbCu_2Si_2$. The thermoelectric power of Cerium compounds has been studied theoretically, within the Coqblin-Schrieffer (CS) Hamiltonian with a crystalline field (CF) splitting Δ, at high [1] and low [2] temperatures compared to the Kondo temperature T_k, and shows a peak at a temperature corresponding to typically $\Delta/3$ and another one at $T_k/2$.

Pressure has a strong effect on Cerium systems and, according to the well known Doniach diagram, it yields an increase of the Kondo coupling. A good example is provided by the change under pressure from an antiferromagnetic ordering to a non magnetic heavy fermion behavior, as observed for example in $CeRu_2Ge_2$ [3]. On the other hand, the effect of hydrogenation is more complicate and presents different behaviors. A classical case is provided by compounds where hydrogenation yields an increase of the lattice parameters, opposite to the effect of pressure. Such a “negative” pressure is invoked in the case of CeRuSi and hydrogenation changes the moderate heavy fermion compound CeRuSi to the antiferromagnet CeRuSiH which has a smaller electronic specific heat constant [4]. A brief discussion of the different behaviors due to the hydrogenation in Cerium compounds is also presented here.

On the other hand, the thermal conductivity of anomalous rare-earth Kondo compounds has been also studied theoretically within the same model with the CS Hamiltonian and CF effects [5]. The magnetic part W_{mag} of the thermal resistivity, taken as the difference between the inverse of the thermal conductivity of the Kondo compound and that of an equivalent non magnetic compound, has been obtained in several Ce, Pr, Tm and Yb compounds and a LogT-dependence of the product $W_{mag}T$ has been observed at sufficiently high temperatures in these compounds, in good agreement with theory and in a way similar to the magnetic part of the electrical resistivity [6].

We present finally a discussion of the transport properties and the resulting figure of merit in strongly correlated electron systems.

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