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Phase diagram of 4f heavy fermion compounds

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The phase diagram of 4f heavy fermions is obtained by the scaling solution of the Anderson model with the crystal field (CF) split states. The results explain the phase boundaries revealed by pressure and doping experiments on intermetallic compounds with Ce, Yb and Eu magnetic ions. The theoretical phase diagram is constructed by comparing the mean-field free energies of the local-moment and aniferromagnetic phases. The Kondo temperature $T_K(g)$ of the CF split multiplet of 4f ions, as function of coupling constant g, is calculated by the non-crossing approximation which replaces the lattice model with the single impurity Anderson model. This Kondo scale agrees with the scaling result of Hanzawa, and we use it to estimate the energy gain due to the singlet formation. The RKKY temperature $T_{RKKY}(g)$ is estimated from the 2^{nd}-order expansion for interaction energy of two magnetic impurities. The mean-field phase diagram obtained in such a way captures the essential features of the experimental data. A comparison with the pressure experiments on $CeRu_2Ge_2$ and Yb_2Pd_2Sn, and doping experiments on $EuCu_2(Si_xGe_{1-x})_2$ is provided.