ORIGIN OF THE PRESSURE DEPENDENCE OF THE KONDO TEMPERATURE IN YB- AND CE-BASED HEAVY-FERMION COMPOUNDS.

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Yb- and Ce-based heavy fermion (HF) compounds demonstrate similar low temperature magnetic, thermal and transport properties. That is why it is especially astonishing that the dependence of the Kondo temperature T_k on pressure in these compounds have opposite characters. While T_k increases with increasing pressure in Ce-based HF compounds, in Yb compounds T_k decreases with increasing pressure.

In the framework of the Anderson model we have analyzed the influence of pressure on the Kondo temperature T_k, the energy of antiferromagnetic coupling J and the valence of rare earth ions. We have showed that the unusual pressure dependence of the Kondo temperature in Yb- based heavy-fermion (HF) compounds can be explained by the competition between two mechanisms of coupling between f-electrons and the lattice. On the one hand an increase of the hybridization between f- and conduction band electron states under pressure results in increase of the Kondo temperature. On the other hand pressure decreases the ionic radius of Yb ions. It leads to the decrease of T_k. Due to the latter mechanism the pressure suppresses valence fluctuations and moves Yb ions from a mixed-valent state towards the localized state Yb^{+3}. We have demonstrated that spin-orbit and crystal-field splitting does not change qualitatively this type of behavior under pressure. We have found that in Yb compounds the Kondo temperature T_k and the coupling constant J reveal a non-monotonous pressure dependence with a broad minimum at a high pressure. This result is in agreement with the unusual behavior of the resistivity under pressure observed in Yb_2Ni_2Al, $YbCu_2Si_2$ and $YbRh_2Si_2$.

In Ce-based HF compounds applying pressure enhances both the hybridization and valence fluctuations. As a result the Kondo temperature and the antiferromagnetic coupling constant J of Ce-based HF compounds increase under applying pressure.

We have also demonstrated that the mechanisms of electron-lattice coupling under consideration can explain the difference in influence of pressure on the competition between the magnetic RKKY interactions and the Kondo effect observed in Yb and Ce compounds. We have compared our theoretical calculations with available experimental data and found qualitative and quantitative agreement.

References

1. A.V. Goltsev and M.M. Abd-Elmeguid, J. Phys.: Condensed Matter, to be published