CRYSTALLINE ELECTRIC FIELD EFFECTS IN SPECIFIC HEAT AND MAGNETORESISTANCE OF PURE AND La-DOPED PrOs₄Sb₁₂

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Introduction

PrOs₄Sb₁₂ is the first Pr-based heavy fermion[1] and unconventional superconductor. Since Pr is a non-Kramers ion, the standard model of heavy fermions based on a Kondo effect, most likely cannot account for low temperature properties of PrOs₄Sb₁₂. New theoretical models require knowledge of CEF configuration of Pr. Our previous investigation of the specific heat in high magnetic fields[2] provided a strong support for a singlet CEF ground state. However, magnetoresistance results for PrOs₄Sb₁₂ seemed to be more consistent with an alternative CEF model, in which nonmagnetic doublet is the CEF ground state[3]. In order to eliminate effects of the field-induced antiferromagnetic order and coherence (due to the periodic Pr-sublattice) on the magnetoresistance we have investigated La-doped PrOs₄Sb₁₂.

Results and Discussion

Specific heat investigation of Pr₁₋ₓLaₓOs₄Sb₁₂ indicated that CEF energies are unchanged between x=0 and 0.2. On the other hand, there seems to be a small increase of CEF energies with x for x>0.2. The magnetoresistance of x=0 has a dome like shape, centered around the crossing field of approximately 9 T. The magnetoresistance of x=0.3 is weakly field dependent below 7 T and above 12 T. Between 7 and 12 T it exhibits a pronounced step which is consistent with numerical calculation of CEF magnetoresistance for the singlet ground state. Furthermore the f-electron magnetoresistance is isotropic, which is again in agreement with the singlet and not the doublet CEF ground state. The magnetoresistance of x=0.05 is has the field variation intermediate between those for x=0 and 0.3. There is little change of the magnetoresistance for x>0.3.

Conclusions

We have shown that the magnetoresistance of moderately and strongly diluted PrOs₄Sb₁₂ is in an agreement with the now-accepted CEF model. We believe that the qualitatively different magnetoresistance of the pure compound is due to coherent scattering by Pr-ions. This coherence is lost near the crossing field.

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References

Author (show first author only, use et al., as appropriate), journal, volume, inclusive page numbers (year). Examples: