9.7 cm

CRYSTAL-FIELD ORIGIN OF THE GIANT MAGNETOCRYSTALLINE ANISOTROPY OF $PrRu_2Si_2$

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$PrRu_2Si_2$ is ferromagnetic below 14 K. It exhibits enormous magnetic anisotropy. A field of 5.5 T applied along the a-axis (the hard direction) induces only 1.3% of the moment observed along the easy axis (the tetragonal c-axis). It points to the anisotropy field of more than 400 T. We have performed calculations of the fine electronic structure of the Pr^{3+} ion in the tetragonal symmetry, relevant to $PrRu_2Si_2$, taking into account crystal-field and inter-site exchange interactions.
Our calculations reproduce well the temperature dependence of the magnetic susceptibility and the heat capacity, in particular the λ-type of peak at T_C. We have calculated magnetization curves that yield so large anisotropy field as 400 T and the magnetocrystalline-anisotropy energy K_1 of 59 J/cm^3. It is the largest known anisotropy - the anisotropy energy of the $Nd_2Fe_{14}B$ supermagnet amounts to 12.5 J/cm^3 only. Unfortunatelly, this giant anisotropy is confined to low temperatures only what prohibits its technical applications in the permanent-magnet industry.
In conclusion, the giant anisotropy field as large as 400 T observed in $PrRu_2Si_2$ can be accounted for by crystal-field interactions.

13.4 cm

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