DE HAAS VAN APLHEN EXPERIMENTS ON $PuMGa_5$ (M=CO,RH) SUPERCONDUCTORS

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Introduction

The discovery of superconductivity at T_c = 18.5 K in $PuCoGa_5$ and at T_c = 9 K in $PuRhGa_5$ has generated renewed interest in Pu-based intermetallic compounds [1]. The thermodynamic properties of $PuMGa_5$ (M=Co, Rh), such as specific heat jump at T_c, are consistent with an electronic specific heat coefficient γ~ 50-100 mJ/mol-K^2 indicating moderately heavy fermion behavior. Recent NMR measurements [2] provide strong evidence for unconventional *d*-wave superconductivity in $PuCoGa_5$ and for a spin fluctuation energy scale that may not be too different from that of δ-Pu. Of central importance for understanding these materials is the role of the 5f electrons in bonding and their degree of localization. Indeed, photoemission experiments reveal a "dual-nature" of the Pu 5f electrons in $PuCoGa_5$ [3]. De Haas van Alphen experiments have been employed to gain insight into the localized/itinerant nature of these remarkable 5f electrons in "Pu115".

Experimental

Single crystals were grown from Ga flux. Due to the radiation damage of ^{239}Pu in the material, the samples were measured within days of being synthesized. The 17 T magnet was used for the dHvA experiments on $PuRhGa_5$ equipped with a torque magnetometer in a ^{3}He cryostat.

Results and Discussion

Figure 1 shows the torque vs magnetic field at various temperatures of $PuRhGa_5$ with H||[001]. The data are consistent with superconductivity below 4 K. From these data, the upper critical field H_{c2}(T) is displayed in Fig. 2. The H_{c2} data are in excellent agreement with those of Ref. [4] and extend the H_{c2} measurements on $PuRhGa_5$ to 0.5 K. Unfortunately, no dHvA oscillations were observed in the present measurements.

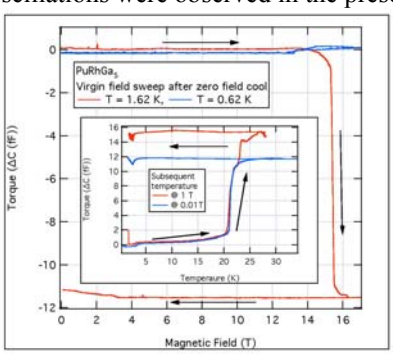

Figure 1 Torque vs magnetic field of $PuRhGa_5$ in magnetic fields up to 17 T.

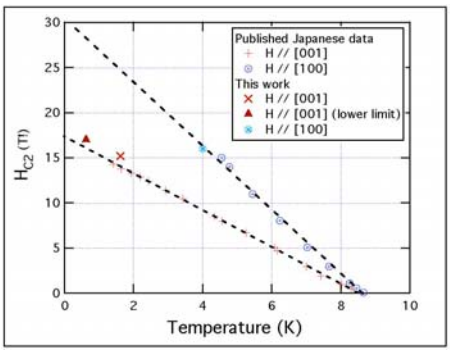

Figure 2 Upper critical field H_{c2} vs T of $PuRhGa_5$.

Conclusions

Measurements of H_{c2} of $PuRhGa_5$ reveal that it continues to increase to lower temperature (H|| [001]), hinting at strong or unconventional coupling. This is strong motivation for the application of higher fields in the search for quantum oscillations.

References

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[4] Y. Haga *et al*, J. Phys. Soc. Japan **74**, 1698 (2005); H. Sakai *et al*, J. Phys. Soc. Japan **74**, 1710 (2005).