High-field de Haas-van Alphen Investigation of the Filled Skutterudite Compound NdOs$_4$Sb$_{12}$

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Introduction

The filled skutterudite compound NdOs$_4$Sb$_{12}$ has a ferromagnetic order below ~1K, which conforms to mean-field magnetism [1]. From the specific heat measurement, a large electronic specific heat coefficient $\gamma \sim 520$ mJ/mol-K$^2$ is determined, which is reminiscent of a heavy fermion behavior. An additional mode appears in the elastic constant $C_{11}$ in ultrasonic measurements [2], which may originate from the tunneling motion of the off-centered sites for a Nd ion [3] and was not found in other rare earth filled skutterudite antimonides. This suggests that NdOs$_4$Sb$_{12}$ may have some abnormal electron-phonon interactions. In order to investigate the electronic structure and Fermi surface topology in this compound, we performed de Haas-van Alphen (dHvA) measurements in NdOs$_4$Sb$_{12}$.

Experimental

Single crystals of the filled skutterudite compound NdOs$_4$Sb$_{12}$ were grown via the molten metal flux technique at UCSD. The dHvA effect of NdOs$_4$Sb$_{12}$ was measured in the Pulsed and Static Field Facility in the National High Magnetic Field Laboratory at Los Alamos and Tallahassee by a susceptometer and a torsional magnetometer down to 0.4 K.

Results and Discussion

Experiment of magnetic susceptibility performed in pulsed fields of H// [100] show dHvA frequencies at $72 \pm 3$, $950 \pm 10$, and $2560 \pm 20$ T (Fig. 1) with cyclotron mass ranging from 0.3 to 2.9 $m_e$, where $m_e \equiv$ bare electron mass. The low frequency ~70 T Fermi surface was also detected in acoustic dHvA. Moreover, the preliminary angle dependence of dHvA frequencies is very similar to that of LaOs$_4$Sb$_{12}$ (Fig. 2). These results indicate that the large $\gamma$ is not from heavy fermion behavior but more likely to originate from some type of low-lying excitations, which may be related to the additional ultrasonic mode.

Conclusions

Fermi surfaces detected in current dHvA experiments in NdOs$_4$Sb$_{12}$ are similar to those of LaOs$_4$Sb$_{12}$ and the effective mass is close to $m_e$. Large $\gamma$ found in the previous specific heat measurement may originate from a low lying excitation.

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References