PULSED-FIELD DE HAAS-VAN ALPHEN STUDIES OF $PrOs_4As_{12}$, $NdOs_4Sb_{12}$, and $SmOs_4Sb_{12}$

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Previous specific heat measurements in several filled skutterudite compounds, $PrOs_4As_{12}$, $NdOs_4Sb_{12}$, and $SmOs_4Sb_{12}$, indicated large specific heat coefficients $\gamma \sim 200$, 520, and 880 mJ/mol-K^2, respectively, suggesting heavy fermion behavior [1, 2, 3]. In order to investigate whether the cyclotron masses in these compounds are enhanced, temperature dependent de Haas-van Alphen (dHvA) measurements were performed on these three filled skutterudite compounds. Single crystals of $NdOs_4Sb_{12}$ and $SmOs_4Sb_{12}$ were grown via the regular molten flux technique [2,3], while those of $PrOs_4As_{12}$ were grown by the same method at high pressures [1]. The dHvA effect of $PrOs_4As_{12}$, $NdOs_4Sb_{12}$ and $SmOs_4Sb_{12}$ was studied in the Pulsed Field-Facility at NHMFL Los Alamos using a pumped ^{3}He refrigerator and 60-T pulsed magnet.

The dHvA measurements were performed on $PrOs_4As_{12}$ for magnetic fields H // [100] and [111], $NdOs_4Sb_{12}$ for H // [100], and $SmOs_4Sb_{12}$ for H // [100] at various temperatures T from ~0.5 K to 4.2 K. The temperature dependence of the dHvA amplitudes was fitted to the standard Lifshits-Kosevich formula to give the cyclotron masses (m_{CR}) shown in Table 1. The 953 T and 2558 T frequencies in $NdOs_4Sb_{12}$ are probably analogous to the 1020 T and 2790 T frequencies observed in $LaOs_4Sb_{12}$ [4], which is expected to have a similar Fermi surface; the masses m_{CR} of $NdOs_4Sb_{12}$ are ~ 2.5 (for 953 T) and ~1.2 (for 2558 T) times larger than their equivalents in $LaOs_4Sb_{12}$. However, the observed cyclotron masses of $PrOs_4As_{12}$ for H // [100] and [111] and $NdOs_4Sb_{12}$ for H // [100] are not large enough to account for large values of γ determined from specific heat measurements. The discrepancy could be due to the existence of other Fermi surface sheets with heavy masses that have not yet been detected.

Table 1 Typical cyclotron masses for various branches of $PrOs_4As_{12}$ for H // [100] and [111] and $NdOs_4Sb_{12}$ for H//[111].

$PrOs_4As_{12}$	F ($\times 10^3$ T)	m_{CR}^* (m_e)
H // [100] <H> = 27.5 T	2.757±0.021	3.2±0.2
	2.930±0.039	3.4±0.2
	3.058±0.024	2.9±0.3
	2.241±0.014	2.4±0.2
	2.442±0.027	3.0±0.2
	2.581±0.018	2.7±0.2
H // [111] <H> = 25 T	3.111±0.059	3.5±0.4
	3.276±0.020	4.1±0.5
	3.434±0.030	4.6±0.7
	1.913±0.011	2.8±0.3

$NdOs_4Sb_{12}$	F ($\times 10^3$ T)	m_{CR}^* (m_e)
H // [100] <H> = 42.5 T	2.558±0.029	2.9±0.2
	0.953±0.018	1.8±0.3

Several $SmOs_4Sb_{12}$ single crystals were measured; however no dHvA oscillations were observed down to ~ 0.5 K. The possible explanations are: (1) disorder in the single crystals, since the $SmOs_4Sb_{12}$ samples usually have lower RRR values compared to $PrOs_4Sb_{12}$, or (2) $SmOs_4Sb_{12}$ has really large values of m_{CR}^* so that the dHvA oscillations cannot be detected in the values of T and H accessed by these experiments.

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