SHUBNIKOV-DE HAAS OSCILLATIONS OF DENSE KONDO LATTICE, $CeAgSb_2$

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Recent measurements of both de Haas-van Alphen (dHvA) and Shubnikov-de Hass (SdH) have been used to study the Fermi surface of the simple tetragonal dense kondo lattice, $CeAgSb_2$ [1,2]. The band-structure calculations proposed that Fermi surface of $CeAgSb_2$ has the largest dHvA frequency of 10.7 kT and several branches with the dHvA frequencies between 40 kT and 90 kT [1]. It has been reported that this compound has magnetic ordering below 9.7 K [3]. The electronic specific heat coefficient γ is 65 mJ K^{-2} mol^{-1}, suggesting the cyclotron effective mass is 65 times larger than the free electron mass m_e. Previous dHvA measurements show the cyclotron masses along the c-axis between $0.85m_e$ and $32m_e$ [1], for dHvA frequencies between 41 T and 11.2 kT [1]. Only one SdH measurement has been reported for B//c where an orbit of ~ 25 T has been observed at 1.2 kbar in the range 18 T at 2.1 K [2]. Since no angular dependent SdH measurements have previously been made, the purpose of this experiment was carry out angular dependent SdH measurements over a broader range of temperature and magnetic field for $CeAgSb_2$ at ambient pressure.

SdH measurements were made using a standard four-probe transport method with in-situ rotation both at ~1.2 K up to 33 T and at ~50 mK up to 18 T. We measured temperature dependent of the SdH oscillation for two different angles in 33 T resistive magnet and angle dependent in 18 T super conducting magnet.

In the 33 T magnet, the temperature dependence of the SdH oscillation was measured for B//c and for 7^0 away from the c-axis. As in Ref.[2], we observe a frequency (~25 T) in the temperature range between 2 K and 3.5 K. We note this is one half the lowest frequency in the dHvA measurement (~40T) [1]. In high field (above 25 T), we observed another frequency (~300 T) below 2 K. Figure 1 shows the effective cyclotron mass (M_c) for the 25 T orbit, which is ~ $3m_e$ (free-electron mass), extracted from the Lifshitz-Kosevich formula. The cyclotron mass obtained in the previous dHvA measurement is only $0.85m_e$ for the frequency 41 T [1]. The dingle temperature that obtained for field parallel to the c-axis and 7^0 to the c-axis are 0.44 K and 0.17 K, respectively. The frequency of SdH at low temperature (~ 50 mK) indicates one or two different frequencies (~ 25 T and ~ 600 T) depending on the angle between the field and c-axis as shown in Fig.2. The inset of Fig.2 shows the maximum amplitude of the oscillation for different angles. The amplitude of the oscillation has a maximum around 95^0, which is 5^0 off from the easy axis (c-axis), and very dramatically decreases above 95^0. The SdH oscillations below 80^0 or above 115^0 are very weak, so that we may not be able to observe any SdH oscillations for the angles out of this range. Both measurements indicate that the SdH amplitudes are very sensitive to magnetic field direction, but we have no explanation for this effect presently. Also, the angle dependence of the low frequency SdH oscillation suggests the Fermi-surface of the system is not cylindrical along c, at odds with the dHvA measurement in the lowest band [1]. Future comparative studies of the dHvA and SdH effects are planned to explore these issues.

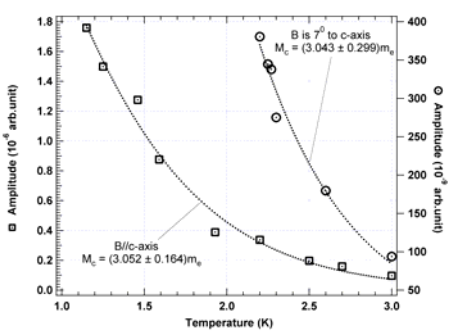

Fig.1 Amplitude of FFT vs. temperature for two different angles (data were taken in the 33T resistive magnet).

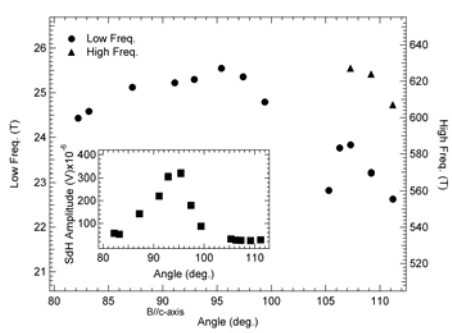

Fig.2 SdH frequency vs. angle, dashed line indicates the tendency of the curve. Inset: the max amplitude of the oscillation vs. angle (data were taken in the 18T superconducting magnet).

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References

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