High Magnetic Field Study of Unusual $Bi_{1-x}Sb_x$

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Introduction

Bi is a semimetal with unusual transport and thermoelectric properties in which there exist electron pockets at L points and hole pockets at T point in Brillouin zone. By substitution of Bi with Sb, the gap between L_S and L_a band closes at around 3-4 % as shown in **Figure 1**: it undergoes three-dimensional (3D) Dirac fermion system with gapless or nearly gapless state at which linear band dispersion appears. This 3D Dirac fermion system shows unusual magnetotransport properties in weak field range, but less high-field studies have been reported up to date.

Experimental and Results

High field magnetotransport experiments were performed in Cell 2 at Los Alamos National High Magnetic Field Laboratory using a 65 T short pulse magnet. **Figures 2 and 3** show the magnetoresistance (MR) and the Hall effect (HE) at 1.5 K with various angles (Θ) in which the magnetic field *H* was tilted from the trigonal axis to the bisectlic axis.

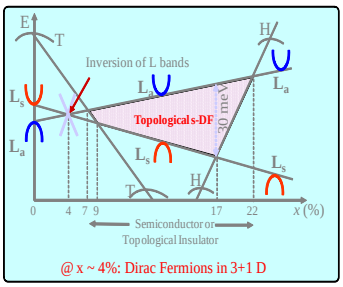

Figure 1. Phase diagram of $Bi_{1-x}Sb_x$

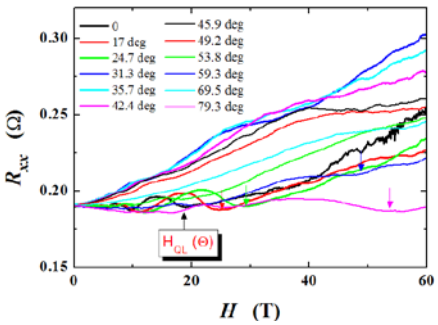

Figure 2. Angular dependence of magnetoresistance.

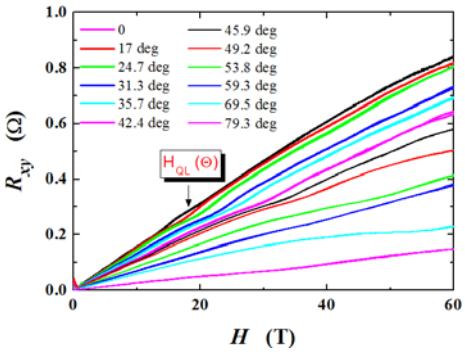

Figure 3. Angular dependence of Hall effect.

Discussion and Conclusions

At Θ = 0, MR shows less field dependence involving SdH oscillation up to 19 T at which the oscillation reaches its quantum limit $H_{QL}(\Theta)$. This oscillation originates from the holes at L point. On the other hand, the HE shows almost linear field dependence up to $H_{QL}(\Theta)$ where a weak kink appears. With increasing tilt angle, $H_{QL}(\Theta)$ shifts to higher field range as shown by the arrows in Figure 2. However, $H_{QL}(\Theta)$ in the HE do not coincide with those in the MR, although the reason is unclear at this moment. From the angular study of the magnetoresistance, we suggest that the shape of the hole pockets is a ellipsoid in this system.

Acknowledgements

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