Quantum magnetotransport oscillatory phenomena in $Pb_{0.6}Sn_{0.4}Te$:Cr Weyl semimetal

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The family of IV-VI narrow gap semiconductors consists of materials with topologically trivial band order as well as topological crystalline insulators with inverted band ordering, e.g. PbTe and SnTe, respectively. This offers natural possibility of tuning topological transition point by alloying mentioned compounds: $Pb_{1-x}Sn_xTe$ [1]. It has been established that this transition between two phases is sharp (x=0.35) only in simplest virtual crystal approximation, while becomes broaden ($0.15<x<50$) in more realistic approach taking into account spatial disorder (lowered local symmetry) and different chemical nature of elemental Pb and Sn [2]. In this extended transition region, the Weyl semimetal phase emerges.

In order to explore such Weyl semimetal phases, we study high magnetic field transport of polycrystalline $Pb_{0.6}Sn_{0.4}Te$:Cr at liquid helium temperatures. Adding chromium dopant was necessary for reaching near zero Fermi energy in the vicinity of the Weyl node. We base on the well-known observation that chromium forms resonant level which pins Fermi energy [3]. We obtained nice Shubnikov de Haas (SdH) oscillations in broad temperature range - from 1.6 K to 45 K and negative magnetoresistance in parallel magnetic and electric fields. This confirmed the existence of Weyl phase. The frequency of SdH oscillations Frq=5.2 T corresponds to $6.7x10^{16}$ cm^{-3} electron density. Standard index plot performed at different temperatures confirmed unambiguously three dimensional character of the Weyl phase and revealed the presence of π-Berry phase.

Additionally, we observed periodic signals of frequencies F and 2F in direct magnetic field as opposed to SdH oscillations. We attribute this to appearance of quantum interference effects: Aharonov-Bohm and Altshuler-Aronov-Spivak, whose origin will be discussed.

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