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Electric transport properties of the thallium-based topological insulators

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Abstract

We report the bulk and surface transport properties of the topological insulator $Tl_{1-x}Bi_{1+x}Se_2$. Observation of the two-dimensional Shubnikov-de Haas effect in addition to the bulk insulating behavior unambiguously confirmed the presence of surface Dirac cone.

Topologically protected surface Dirac cone is one of the new stages of novel electric and spin transport. The Dirac cone is realized in some bulk crystals which is nowadays called the three-dimensional topological insulators. The new Dirac fermion system is of great significance because the absence of spin degeneracy coexists with the time reversal symmetry, and the surface Rashba spin-orbit interaction locks the direction of electronic spin [1,2]. Although a spin transport in the unique spin texture has been attracting much interest [3], majority of the topological insulators also involves undesirable bulk metallic conduction which complicates the situation.

Recently, K. Kuroda *et al.*, reported the bulk insulating property and bulk carrier manipulation in the topological insulator $TlBiSe_2$ [4]. This is the first demonstration of the bulk insulating properties other than the well-known Bi_2Se_3 family. Since the $TlBiSe_2$ is known to exhibit an in-gap Dirac point [4], the Dirac cone is appropriate to investigate the novel phenomena of transport with fully-controlled Fermi level, as demonstrated in graphene [5] (Figure 1).

In this presentation, we report the electric transport properties of the bulk insulating, surface metallic $Tl_{1-x}Bi_{1+x}Se_2$. Observation of the two-dimensional quantum oscillations with non-zero Berry phase confirmed the success of electric transport in the surface Dirac cone [6]. We also compare the properties obtained to that of another Dirac fermion system and discuss the effective theoretical model.

References

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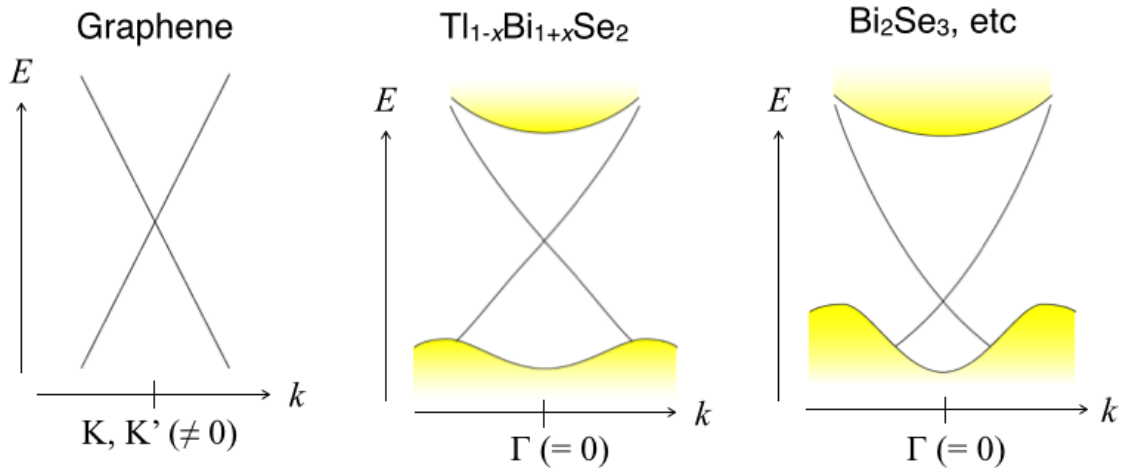

Figure 1: Schematics of known Dirac fermion systems.