強磁場下におけるビスマスの電子状態
Electronic States of Bismuth in High Magnetic Fields

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In this decade, so-called "topological semimetals" have attracted considerable attention. In this class of materials, characteristic linear band dispersion can be expressed by relativistic Dirac/Weyl equation. Therefore, a great number of studies were devoted to explore unusual kinetic properties of high-energy particles through the experiments on condensed matters. To investigate kinetic properties of the carriers, (magneto)transport properties of this class of materials have been extensively studied. The results and also their interpretation, however, are sometimes controversial. In particular, relationship between the band topology and macroscopic physical properties remains unclear. Therefore, systematic studies on materials in which band topology can be modified in a controllable method are highly important.

Elemental bismuth has long been known as a good material to easily observe the phenomena that are inherent in all metals [1]. Application of high magnetic fields along the binary axis has been believed to cause shift of the energy bands similar to the case of antimony substitution (Fig. 1), and hence, may realize topological insulating state as observed in $Bi_{1-x}Sb_x$ [2] above the semimetal-semiconductor (SMSC) transition field [3]. On the other hand, recent ARPES experiments claimed that band topology of bismuth was already non-trivial even without antimony substitution or applying magnetic fields [4]. Therefore, careful re-examination of the electronic states in bismuth under high magnetic fields became an important issue in topological physics. In this context, we performed studies of magnetoresistance, magnetization, magnetostrcition, and ultrasound measurements on single crystals of bismuth in pulsed magnetic fields up to 60 T. Through these experimental results, we discuss the electronic state of bismuth exhibiting field-induced complete valley polarization and also novel anomaly in magnetoresistance. In the last part of the presentation, I will propose future FIR experiments that can be the key to solve some open questions in this material.

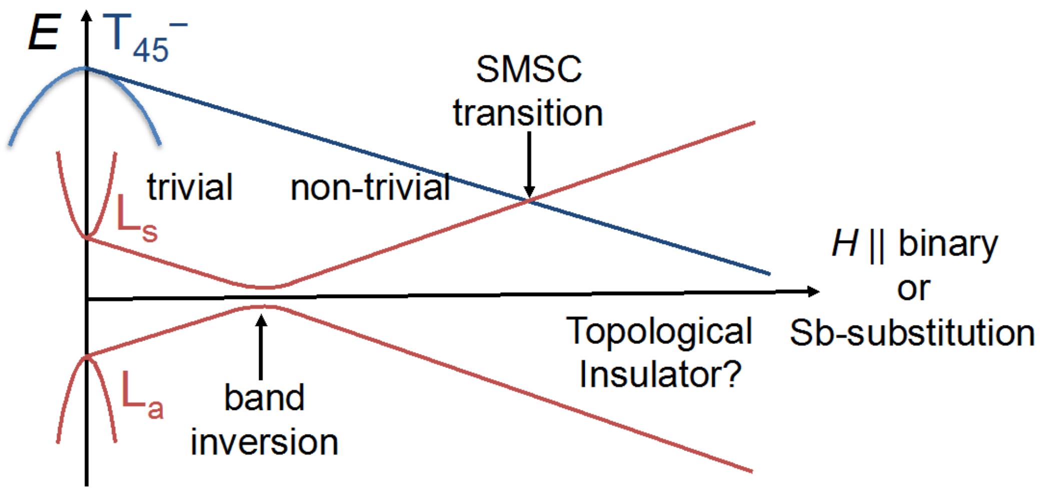

Fig. 1. Schematics of band shift in bismuth by applied field or antimony substitution.

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