CONDENSED MATTER PHYSICS SEMINAR SERIES

PbSnSe: a model platform to study topological phases

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Topological matter has recently been a wide source of interest in condensed-matter physics. Due to spin-orbit interaction, an inversion in the band parity can occur for this kind of materials. In particular, the topological crystalline insulator Pb 1-x Sn x Se can host an inverted band structure highly tunable with external knobs like composition, temperature, or strain. In this inverted configuration, four gapless Dirac cones emerge at the surface of the material. Controlling these topological surface states remains a big challenge as it would go along many very important applications in ultrafast electronic devices or quantum computing based on Majorana states.

In this presentation, we will study the Pb 1-x Sn x Se three-dimensional band structure dependence with chemical composition, temperature, and strain by using magneto-optical experiments. MBE grown (111)-oriented Pb 1-x Sn x Se exhibit very high mobilities (>10,000 cm^2/Vs) and low Fermi energy (n~10 17 cm -3) that makes it a very clean semi-conductor material. The control of the bulk band parameters demonstrated here will have a direct impact on the 2D properties of this material.

We performed infrared magneto-optical transmission measurements in PbSnSe/PbEuSe superlattices to evidence the optical activity of the topological surface states in these materials. We also show their tunability with temperature and confinement, which is due to the very highly versatility of PbSnSe.

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