Title:	Transport spectroscopy on novel quantum materials
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Abstract: Emergence of novel quantum materials like ferromagnets, superconductors, topological non-trivial materials have introduced new possibilities to the condensed matter physics re- search. Although the discovery of quantum Hall effect (QHE) triggered the notion of the existence of topological non-trivial materials; the primitive idea, however, was highly mo- tivated by the high-energy physics. These systems may accommodate relativistic particles such as Majorana Fermions, Dirac Fermions, Weyl Fermions, etc. Many theoretical pro- posals suggest the realization of these relativistic particles in exciting condensed-matter systems. Some signatory evidences have already been experimentally seen, like Weyl fermions have long been known in quantum field theory, but have not been observed as a fundamental particle in nature. A Weyl semimetal is a new state of matter that hosts Weyl fermions as emergent quasiparticles. This eventually opens up the opportunity to realize the relativistic particles in a relatively smaller experimental setup. In this thesis we report the emergence of the synthetic gauge field and a consequent pseudomagnetic field in a doped Weyl semimetal. Further, if we talk about other novel quantum materials like ferromagnets; ferromag- nets are well known for spin phenomenon. In conventional electronics, electronic charge is used for device operation, but using electron's other fundamental property, spin, in ad- dition to or at the place of electronic charge, gives rise to a new field called Spintronics. Spintronics is the branch of physics which deals with the transfer, storage and manipu- lation of information by means of electronic spin. Traditionally spin phenomena have been detected in ferromagnetic metals and alloys, spin generation and spin-orbit coupling in non-magnetic materials has been revealed recently. The recently discovered topolog- ical non-trivials materials like topological insulators have presented new possibilities for spintronics. I will discuss measurement of transport spin-polarization on two systems (i) a complex ferromagnet EuTi 1−x Nb x O 3 and (ii) a series of doped topological insulators (Bi 2 Se 3). 3To justify the above works, we have chosen the following thesis plan: Chapter I is an introduction to the work presented in the thesis. This thesis deals with the novel quantum properties of topological non-trivial materials and an itinerant ferromagnet. Some brief introduction about Weyl semimetals and topological insula- tors is included in this chapter. The methods and attempts that have been made for spin-polarization measurements in ferromagnets and topological materials, have been dis- cussed here. This chapter also includes detailed discussion of point-contact spectroscopy (PCS) on mesoscopic NS junctions in different regimes of transport followed by the dis- cussion of theoretical model. Chapter II describes details of the experimental techniques used in this thesis work. The scanning tunneling microscopy (STM) and point contact Andreev reflection (PCAR) spectroscopy are used in most of the experiments in the work presented here. A scan- ning tunneling microscope (USM 1300, Unisoku) is used for the transport spectroscopy experiments in the tunneling regime. The experiments are carried out down to 300 mK temperatures and up to 11 T magnetic field. For the transport spectroscopy in the metallic regime, point contact Andreev reflection (PCAR) spectroscopy is employed. A point con- tact spectroscopy probe is developed in-house to carry out dI/dV measurements at low temperatures down to 1.4 K and high magnetic field of about 6 Tesla. The data acquisition set-up and method developed in house, is discussed in this chapter. Chapter III shows the emergence of pseudo-magnetic field in type-II Weyl semimetal on inducing strain in the system. It is known that an external magnetic field facilitates re- alization of a great variety of unique properties like quantum Hall effect, chiral anomaly, magneto-electric effect etc. in certain novel materials. What if we harbour these proper- ties intrinsically in a material! Harbouring these properties can, in principle, make their implementation possible in new generation technology and fundamental research. In this direction, synthetic generation of an intrinsic magnetic field is a viable alternative which, as per quantum field theory, can be achieved in Dirac/Weyl fermionic systems under inho- mogeneous strain. This effect was earlier observed by scanning tunneling spectroscopy 4in graphene, a 2D Dirac material, at localized nano-bubbles under strain. Here, I will present the first experimental evidence of an intrinsic strain-induced pseudo-magnetic field (3 Tesla) over a large area in a three-dimensional type-II Weyl semimetal. Chapter IV In chapter 4, I will present the measurement of the transport spin po- larization of EuTi 1−x Nb x O 3 . It is important to understand temperature evolution of the magnitude of spin polarization in novel quantum materials. EuTi 1−x Nb x O 3 is a low Curie temperature complex itinerant ferromagnet. The low T c of this material enables us to extract the transport spin polarization all the way up to T c from point contact Andreev reflection spectroscopy using Nb tip. Here I will also show how generically the spin po- larization evolves with temperature proportionately with the bulk magnetization even for a complex material with strong correlations. Chapter V Here I will discuss about evolution of spin-polarization of Bi 2 Se 3 on dop- ing with a magnetic element (Mn). The motivation to work on topological materials is due to their extraordinary behaviour like high spin polarization which may lead to a new aspect of quantum physics as well as in the technological world : spintronic devices, the key element for quantum computing which may drive us into a completely new gener- ation world. Perturbations like magnetic dopant, structural distortion, mechanical strain and disorder etc. can be used to realize novel phases of matter out of topological insula- tors. In chapter 5, we will see that Bi 2 Se 3 surface states show a very large magnitude of spin-polarization. And I will show that on doping Bi 2 Se 3 with Mn dopants, the effective spin-polarization of the material is reduced.