Master's thesis – track Advanced Matter and Energy Physics

'Exploratory research of the 3D topological insulator $Bi_{1.5}Sb_{0.5}Te_{1.3}Se_{1.7}$ by means of magnetotransport'

Abstract:
Magnetotransport measurements offer a promising route to study the surface states of the 3D topological insulator $Bi_{1.5}Sb_{0.5}Te_{1.3}Se_{1.7}$ (BSTS). Here magnetotransport is reported on BSTS in magnetic fields up to 14T and temperatures as low as 100mK. We used BSTS samples with resistivity values exceeding 10cm at base temperature, which is the highest resistivity value reported so far for this material. However, the bulk remains to dominate the transport. In order to study the surface states of a 3D topological insulator, bulk and surface contribution need to be separated. Three phenomena are explored as possible candidates for studying the surface states of the 3D topological insulator. First, Shubnikov-de Haas (SdH) oscillations are observed which are interpreted as originating from the 2D surface. Furthermore, two different quantum interference effects are observed and interpreted as weak anti-localization (WAL) and universal conduction fluctuations (UCF's). It is surprising quantum interference phenomena such as UCF's can be observed in 3D mm-sized samples since these are usually seen in mesoscopic disordered metals. Magnetic field angle and temperature dependent measurements are performed and analyzed to determine whether these effects originate from the surface (2D) or the bulk (3D). We find that the surface contributes to both WAL and UCF's. Furthermore we discuss several techniques on how to isolate the surface contribution. We will end this thesis with suggestions for further exploring the surface states of a 3D topological insulator using Shubnikov-de Haas oscillations and the quantum interference effects.