



Topological Insulators: Chapter 8. Transport Experiments on Three-Dimensional Topological Insulators (Contemporary Concepts of Condensed Matter Science)

Jeroen B. Oostinga, Alberto F. Morpurgo

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The discovery of topological insulators as a new state of matter has generated immense interest in this new class of materials. Three-dimensional (3D) topological insulators are characterized by the presence of an odd number of families of Dirac fermions—ideally one- at each of their surfaces. Angle-resolved photoemission experiments have demonstrated the presence of the expected Dirac fermions, but it is clear that to explore the electronic properties of these systems, transport measurements in many different device geometries are called for, just as it has been the case for Dirac fermions in graphene. In this chapter we review the status of transport studies through 3D topological insulators as of early summer 2012, after that a first generation of experiments has been performed. The results provide many different indications of the presence of surface fermions, as well as evidence of their Dirac nature. However, no textbook “manifestation” of surface Dirac fermions has been reported so far in these materials. Indeed, experiments also show that investigations are severely hampered by the material quality in most cases, because of the effect of high conductivity in the bulk, of low carrier mobility, of technical difficulties hampering device fabrication, and other reasons. In this chapter, we attempt to give a balanced overview of the work done during this first period and of the results obtained, stressing the implications and the limits of many of the observations that have been reported in the literature.

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