

Research Project

Generic Helical Liquids in 2D Topological Insulators: Transport Properties and Applications

Third-party funded project

Project title Generic Helical Liquids in 2D Topological Insulators: Transport Properties and Applications

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Organisation / Research unit

Departement Physik / Theoretische Physik (Bruder)

Department

Project start 01.09.2015

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Status Completed

This research proposal focuses on the investigation of electronic transport properties of metallic helical edge states of two-dimensional topological insulators. The objectives can be divided into two major parts. The first part is devoted to the investigation of fundamental properties of the helical liquids. In a recent paper [Schmidt et al., Phys. Rev. Lett. 108, 156402 (2012)], we introduced the concept of a generic helical liquid (GHL). This is the most general model of a time-reversal invariant helical liquid without axial spin symmetry. This symmetry is usually broken in experimental realizations, and we showed that its absence changes the transport properties significantly. In the first part of this project, we will investigate transport properties of interacting GHLs in the presence of disorder, the effect of a weak breaking of time-reversal symmetry, and we will develop proposals on how to measure the spin structure of the helical edge states. The second part focuses on nanostructured geometries of two-dimensional topological insulators which can be realized in experiments and allow a more detailed characterization of the properties of GHLs. In particular, we shall examine antidots, which are coupled by tunnelling to the edges of the sample. We shall use a combination of numerical and analytical techniques to determine the current through such an antidot. We expect it to display a distinctive interference pattern which is unique to GHLs. Moreover, we shall investigate the role of the charging energy on the antidot and the possible emergence of the Kondo effect.

Keywords Condensed matter physics; Quantum mechanics; Topological insulators; One-dimensional systems

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