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Probing Disorder Effects in Topological Materials via Non-Linear Hall Response

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Topology and geometry have recently emerged as pillars for exotic phenomena in condensed matter physics. From topological insulators and superconductors to quantum Hall states and fractional statistics, these phenomena have the potential to revolutionize technology in the areas of spintronics, low-energy electronics and quantum computing. The non-linear Hall effect (NLHE) is an example of such an exotic phenomena. Without a magnetic field, it is possible to generate a Hall response in samples with non-trivial quantum geometry. In this project, the influence of granular disorder on the NLHE in the three-dimensional topological insulator Bi₂Te₃ is studied through a combination of experimental measurement and theoretical analysis. More precisely, Bi₂Te₃ samples with varying grain size will be fabricated and their Hall responses measured, which are then to be analyzed through the Boltzmann transport framework. This analysis aims to understand the interplay between disorder strength and the quantum geometric properties of Bi₂Te₃, in particular, its Berry curvature dipole, and determine which contribution to the NLHE dominates, the disorder-induced contributions or the quantum geometric contribution. This project will contribute to the growing understanding of topology and quantum geometry in disordered quantum matter, which is indispensable for the development of realistic technologies.

Field of Research/Work

Condensed Matter and Materials

Author: BAPTISTA, João