

Transversal transport coefficients and topological properties

tutorial

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Abstract

Spintronics is an emerging field in which both charge and spin degrees of freedom of electrons are utilized for transport. Most of the spintronic effects – like giant and tunnel magnetoresistance – are based on spin-polarized currents which show up in magnetic materials; these are already widely used in information technology and in data storage devices.

The next generation of spintronic effects is based on spin currents which occur in metals as well as in insulators, in particular in topologically nontrivial materials. Spin currents are a response to an external stimulus – for example electric field or temperature gradient – and they are always related to the spin-orbit interaction. They offer the possibility for future low energy consumption electronics.

The talk will present a unified picture, based on topological properties, of a whole zoo of transversal transport coefficients: the trio of Hall, Nernst, and quantum Hall effects, all in their conventional, anomalous, and spin flavour. The formation of transversal charge and spin currents as response to longitudinal gradients is discussed. Microscopic insight into all phenomena is presented by means of a quantum mechanical analysis based on the Dirac equation in combination with a semi-classical description which can be very elegantly studied within the concept of Berry curvature.

Speaker

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