Topological Hall effect and Berry phase in magnetic nanostructures

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Abstract:

We discuss the anomalous Hall effect in a two-dimensional electron gas subject to a spatially varying magnetization. This topological Hall effect (THE) does not require any spin-orbit coupling, and arises solely from Berry phase acquired by an electron moving in a smoothly varying magnetization. We propose an experiment with a structure containing 2D electrons or holes of diluted magnetic semiconductor subject to the stray field of a lattice of magnetic nanocylinders. The striking behavior predicted for such a system (of which all relevant parameters are well known) allows to observe unambiguously the THE and to distinguish it from other mechanisms [1].

Next we discuss the electronic structure of a 2D electron gas subject to a 2D-periodic effective magnetic field and investigate the band structure which develops. We show that chiral electronic states are obtained, giving rise to persistent currents, in absence of a net magnetic flux.