How Surfaces Berry-curve Bloch-electrons

Jeroen van den Brink[1]

[1] *Institute for Theoretical Solid State Physics, IFW Dresden, Helmholtzstr. 20, 01069 Dresden, Germany*

The anomalous velocity of Bloch electrons inside a solid that is caused by the electronic Berry curvature leads to a sideways deflection of currents and is the root cause of a plethora of interesting Hall-type charge, spin and heat transport responses[1]. Not only the canonical quantum Hall effect in external magnetic field and magnetization induced anomalous Hall effect result from the anomalous velocity, but so do in non-magnetic systems the spin-Hall conductivity and a set of nonlinear Hall and Nernst effects[2–5]. It should be noted however that in presence of both time-reversal and inversion symmetry the Berry curvature associated to the electronic structure of three-dimensional bulk crystals vanishes identically, such as for instance in elemental bismuth.

We show that in spite of this fundamental obstacle at *surfaces* and interfaces of such crystals a finite surface Berry curvature (SBC) can arise[6]. At general Miller-index surfaces Bloch-electrons attain a finite anomalous velocity, the cause of various anomalous Hall-type transport properties. Using surface Green functions we quantitatively determine from the full bulk electronic structure the SBC associated to different surfaces of Bi and (strained) HgTe. As a consequence Bi ($\bar{1}10$) is SBC free due to a two-fold rotation around the surface normal, Bi (111) has a finite SBC but vanishing SBC dipole, whereas Bi (100) has an appreciable SBC dipole due the presence of just a single mirror line[6].

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