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"Spin-orbit" susceptibility in the quantum spin Hall systems
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There are two classes of insulators showing the spin Hall effect. One is a spin Hall insulator such as PbTe while the other is a quantum spin Hall system. They are distinguished by an absence or presence of edge states. To study such insulators showing the spin Hall effect, we construct a spin analog of the Středa formula. We use the conserved spin current as proposed by Zhang et al.[cond-mat/0503505], thereby the resulting Středa formula becomes quite simple (i.e. without any $\dot{\mathbf{s}}$ terms). As a result, the spin Hall conductivity for band insulators is proportional to a "spin- orbit" susceptibility, representing a response of the orbital magnetization to the Zeeman field (or equivalently a response of the spin magnetiation to the orbital magnetic field). We apply the result to real systems such as $Bi_{1-x}Sb_x$, because in insulating $Bi_{1-x}Sb_x$ the diamagnetic susceptibility is largely enhanced due to the spin-orbit coupling.

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