Topological insulators: magnetoelectric and disorder effects

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"Topological insulators" are insulating in bulk but have protected metallic surface states as a result of topological properties of the electron wavefunctions. Several examples have been discovered recently in ARPES experiments that directly probe the surface state, including its spin structure. One way to characterize the topological insulator is through its magnetoelectric response in a weak applied field: it generates an electrical polarization in response to an applied magnetic field, and a magnetization in response to an applied electrical field. This talk first reviews the origin of this response and its generalization to other insulators and topological states. A complete formula for the orbital contribution to the magnetoelectric polarization is given. It includes a topological part that is the only contribution in topological insulators.

We then discuss some features of disordered topological insulators, concentrating on the two-dimensional case and on thin films of three-dimensional topological insulators. These features should be observable in charge transport and optical experiments.