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Localized modes of an electron by topological insulator defect

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Topological insulators, a new class of materials discovered recently, have very unique topological properties. While the surface states are gapless and are topologically protected by the time reversal symmetry, the bulk of topological insulator shows a full gap. We study the properties of reflected and transmitted electron waves on the surface of topological insulator nanofilm with a defect. We show that an electron incident on a defect produces modes, which are localized at the defect. Such modes result in an enhancement of electron density at the defect. If an electron with a given energy E is incident on a region of the TI nanofilm which does not support electron propagating waves at energy E, then there is a strong enhancement of local electron density near the boundary of such region. We calculate the reflectance and transmittance of an electron from such a defect for different parameters of the topological insulator nanofilm and different parameters of the defect. The amplitude of the electron wave strongly depends on the position of electron energy. If electron energy is in the energy gap of defect, then the reflectance is 1. This result corresponds to total internal reflection. If the electron energy is not in the energy gap of defect, then the reflectance is small and the electron is almost totally transmitted. The critical points dividing these two boundaries are defined by the condition that the electron energy is at the band edge of energy dispersion. The dependence of the electron wave on the parameters of the system, such as thickness of the nanofilm or electron energy, is dominated near the critical points.

Keywords: Topological insulator, Absorption spectrum, Topologically protected systems