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Decay length of edge/surface states in topological insulators SHUICHI MURAKAMI, Department of Physics, Tokyo Institute of Technology and PRESTO, JST — Edge states of 2D quantum spin Hall (QSH) systems or surface states of 3D QSH systems are localized near the boundary of the systems, whereas their decay length ℓ may vary. We study their generic behaviors in the presentation. We first note that ℓ^{-1} plays the role of the imaginary part of the wavenumber perpendicular to the edge/surface, and $\ell = \infty$ when the edge/surface states are absorbed into the bulk bands. We calculate ℓ and discuss their behaviors by using effective models. In accordance to our expectations, we can show that the ℓ is shorter when the edge/surface states are far away from the points where the edge/surface states are absorbed into the bulk bands. The edge states in HgTe quantum well or the surface states in Bi_2Se_3 have Dirac-like dispersion and longer ℓ, while in Bi ultrathin films or $Bi_{1-x}Sb_x$, ℓ is as short as the lattice constant because the edge/surface states spread almost over the Brilloin zone. In particular, in the Dirac-like bands, the minimum ℓ corresponds to the inverse of the k-space size of the Dirac cone of the edge/surface states. The QSH systems with shorter ℓ will be more favorable for real-space observation of edge/surface states.

Shuichi Murakami
Department of Physics, Tokyo Institute of Technology and PRESTO, JST

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