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Well-localized edge states in two-dimensional topological insulator: bismuth film MASAKI WADA, Department of Physics, Tokyo Institute of Technology, SHUICHI MURAKAMI, Department of Physics, Tokyo Institute of Technology and PRESTO,JST, FRANK FREIMUTH, GUSTAV BIHLMAYER, Institut fuer Festkoerperforschung, Forschungszentrum Juelich — We calculate the Z_2 topological numbers of bismuth (111) and {012} ultrathin films from 2D tight-binding Hamiltonians obtained by first-principle calculation. We find that Bi(111) 1-bilayer is the quantum spin Hall (QSH) phase, while Bi{012} 2-monolayer is not. We calculate the QSH edge states of the (111) 1-bilayer film with zigzag edges, and there are three Kramers pairs of edge states at the Fermi energy, resulting in the two terminal conductance $G = 6e^2/h$. It will be reduced to $G = 2e^2/h$ by increasing nonmagnetic disorder, but will not vanish because of the topological protection. Compared with the known two-dimensional quantum spin Hall systems such as HgTe quantum well, the decay length ℓ of edge states of bismuth (111) 1-bilayer system is much shorter and is of the order of a few lattice constant. This short ℓ is attributed to the edge-state dispersion traversing over the Brillouin zone. It is in strong contrast with HgTe quantum well, where ℓ might be as long as 50nm.

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