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Engineering quantum anomalous Hall phases with orbital and spin HONGBIN ZHANG, FRANK FREIMUTH, GUSTAV BIHLMAYER, STEFAN BLÜGEL, YURIY MOKROUSOV, Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich and JARA — Combining tight-binding models and first principles calculations, we demonstrate that under external exchange fields, non-zero Chern numbers and nontrivial QAH effect could be induced by on-site spin-orbit coupling (SOC) in buckled honeycomb lattices with *sp* orbitals. In the Haldane model [1], the occurrence of QAH effect is attributed to complex next nearest neighbor hopping. Detailed analysis of a generic tight-binding models reveals that there exist different mechanisms giving rise to complex hoppings, utilizing both orbital and spin degrees of freedom of electrons on a lattice. Furthermore, it is shown that in Bi/Sb(111) bilayers [2], different topological phases exist as function of the magnitude of SOC and external exchange fields. These phases are characterized using Chern and spin Chern numbers [3] together with transverse charge and spin conductivities. At last, we show that introducing ferromagnetic dopants provides a practical way to induce nontrivial topological phases, whereas the physics is modified due to incompletely filled d states around the Fermi energy.

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