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Honeycomb lattice with multiorbital structure: Topological and quantum anomalous Hall insulators with large gaps[1] GU-FENG ZHANG, Univ of California - San Diego, YI LI, Princeton University, CONGJUN WU, Univ of California - San Diego — We construct a minimal four-band model for the two-dimensional topological insulators and quantum anomalous Hall insulators based on the p_x- and p_y-orbital bands in the honeycomb lattice. The multiorbital structure allows the atomic spin-orbit coupling which lifts the degeneracy between two sets of on-site Kramers doublets $j_z = \pm\frac{3}{2}$ and $j_z = \pm\frac{1}{2}$. Because of the orbital angular momentum structure of Bloch-wave states at Γ and $K(K')$ points, topological gaps are equal to the atomic spin-orbit coupling strengths, which are much larger than those based on the mechanism of the $s-p$ band inversion.The energy spectra and eigen wave functions are solved analytically based on Clifford algebra. The competition among spin-orbit coupling λ, sublattice asymmetry m, and the Néel exchange field n results in band crossings at Γ and $K(K')$ points, which leads to various topological band structure transitions. The quantum anomalous Hall state is reached under the condition that three gap parameters λ, m, and n satisfy the triangle inequality. Flat bands also naturally arise which allow a local construction of eigenstates. The above mechanism is related to several classes of solid state semiconductor.

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