

Topological-topological Flat Bands

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Electronic flat bands have localized Wannier-like orbitals as zero modes. In the Lieb or the kagome models, the localized orbitals satisfy a topological condition that entails two non-contractible loop eigenstates along x/y -axis in real space, and one topological band touching point with other bands in momentum space. In these topological-flat bands, the Bloch state at the touching point is ill-defined, and so is any topological invariant for the entire band. We propose a new topological condition that the loop states in different directions be linearly dependent. Its satisfaction removes the singularity at the band touching point, and enforces nontrivial, well-defined topological invariants. Enforcing the new condition, we obtain topological-topological (top^2)-flat bands in 2D and 3D that have nontrivial invariants including the Chern numbers, the $\mathbb{Z}_2$ invariants, and the topological-crystalline invariants. Under small, generic interactions, top^2 -flat bands flow to correlated topological insulators with a dynamically generated, symmetric mass term; and specially designed interacting models can have top^2 -flat bands as exact zero modes.