Topological flat mini-bands in moiré superlattice materials

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The emergence of topologically non-trivial flat bands in moiré materials provides an exciting opportunity to explore the interplay between topological physics and correlation effects, culminating in recent experimental discoveries of interacting topological phases, such as fractional Chern insulators, in graphene and transition metal dichalcogenide moiré systems. In this talk, we extend these insights to propose strategies for engineering topological flat minibands in two-dimensional (2D) systems combining moiré superlattice potentials and strong spin-orbit coupling. Particularly, we propose (1) topological minibands in topological insulator based moire heterostructures;[1] (2) a band-folding-induced band inversion mechanism for topological minibands in two types of semiconducting models, namely the Rashba model and the Bernevig Hughes-Zhang (BHZ) model with moiré superlattice potentials;[2] (3) a topological heavy-fermion description for topological flat minibands in a specific class of moiré materials exhibiting type-II quantum well features; and (4) symmetry-enforced topological moiré mini-bands. A general theory based on band representations in the morié Brillouin zone has been developed for diagnosing the topological characteristics of moiré minibands that results from the interplay between atomic effective model and moiré superlattice potentials for all 2D crystalline space groups.

References

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