

Topological Mini-bands in Rashba Spin-orbit-coupled Moiré Materials and beyond.

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Abstract: We study the topology of moiré minibands in a Rashba spin-orbit-coupling (SOC) model and a Bernevig-Hughes-Zhang (BHZ) model subjected to a moiré superlattice potential with a six-fold rotation symmetry induced by another two-dimensional insulating material. For Rashba SOC moiré materials, a band inversion happens at Γ between the original states at Γ and the folded states from moiré reciprocal lattice vectors when increasing the Rashba SOC to be comparable with the moiré mini band width. When the moiré potential opens gaps between moiré minibands after the band inversion, the lowest conduction mini band becomes isolated from higher energy bands and Z_2 nontrivial. From atomic limit perspective, the two s-wave atomic orbitals located at the honeycomb lattice formed by the six-fold symmetric moiré potential minima contribute to two low energy conduction bands. The lowest one band thus lacks an atomic limit and is topologically nontrivial. In the case of the topologically nontrivial BHZ model under the moiré potential, topologically nontrivial lowest conduction mini bands are found when adding moiré potentials. Band inversion also appears by tuning the inverted gap at Γ with the occurrence of fragile topological bands. We propose the III-V semiconductor quantum wells as a possible experimental realization for Rashba moiré materials with greatly tunable Rashba SOC through out-of-plane electrical fields.