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Engineering topological states in graphene systems

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In this talk, I will introduce our recent progress on engineering various topological states in graphene systems. The presentation includes two parts: (i) We show that in monolayer graphene, Rashba spin-orbit coupling (SOC) together with Zeeman field can open a nontrivial bulk gap to host the quantum anomalous-Hall effect [1]. We further show that this can be realized via doping magnetic metal atoms on graphene [2,3]. In Bernal stacking bilayer graphene, an interlayer potential difference breaks the inversion symmetry and opens a bulk gap to support the quantum valley-Hall effect. We find that Rashba SOC can induce a topological phase transition from the quantum valley-Hall effect to a Z2 topological insulator [4]. When the Zeeman field is further considered, a rich variety of topological phases emerge. (ii) When the mass term (e.g., sublattice potential in monolayer graphene, or interlayer potential difference in bilayer graphene) varies spatially, topologically protected 1D kink states arise along zero lines. We demonstrate that such 1D kink state exhibits zero bend resistance for arbitrary turns in its propagating path [5]. We further point out that similar kink states can be tailored in graphene nanoroads in boron nitride sheets [6]. When the kink current experiences a crossing junction composed of four zero lines, we find the splitting of the 1D kink state at the bifurcation point obeys an explicit law of current partition [7].

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