Interaction-driven Thouless pumping in all-flat-band lattices

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Thouless pumping consists in the quantized transport of particles through a periodic system via the adiabatic, cyclic modulation of its parameters. This phenomenon, traditionally understood via topological invariants, provides a robust framework for exploring the interplay between geometry, transport, and many-body interactions. In this talk, we explore Thouless pumping of interacting bosons in lattices characterized by single particle flat bands. The complete absence of dispersion in these systems turns all eigenstates strictly compact in space, which suppress all single particle diffusion. Using the Creutz ladder as testbed, we show that the interaction enables quantized transport of bound boson pairs via proper driving of the system. Our demonstration relies on unitary mappings characteristic of certain classes of flat band lattices, which allow to recast the interacting Creutz ladder into a Rice-Mele like chain, and show the topological nature of the pumping. This interaction-induced pumping is a feature appearing in a broad class of physically relevant flat band models beyond the Creutz, e.g. the rhombic chain under a uniform magnetic flux. Finally, we show that this phenomenon is a strictly quantum effect, since it breaks down in the classical mean-field (nonlinear) limit as the particle number approaches infinity.