Stability of Laughlin type and composite fermion states in Chern insulators

Pawel Potasz and Błażej Jaworowski[1]

[1] *Wroclaw University of Science and Technology, Wrocław, Poland*

Chern insulators are band insulators exhibiting a nonzero Hall conductance but preserving the lattice translational symmetry. [1] Fractional Chern Insulators (FCI) are partially filled Chern Insulators that exhibit fractional quantum Hall effect. [3-5] This happens when energy of two particle interaction substantially exceed energy dispersion of topologically nontrivial band. In this work, we consider Lieb lattice within tight-binding model which characterizes by three energy bands with a peculiar perfectly flat middle band. We show that the topology of the energy bands can be controlled by next-nearest-neighbor hoppings in the Haldane model and a staggered sublattice potential. [6] We analyze an existence of Laughlin type and composite fermion (CF) states in Fractional Chern Insulators (FCI) using exact diagonalization. We first show that the system at 1/3 filling of quasi flat band with nontrivial topology exhibits an incompressible phase characterized by a 3-fold degenerate ground state with spectral flow upon flux insertion, constant density, and counting of levels below the gap identical to that of Laughlin 1=3 quasiholes. This Laughlin type phase exists in a large region of parameter space which we show is related to constant standard deviation of Berry curvature [7]. Next, we consider different filling factors searching for CF phases. We analyze many-body energy spectra for 2/5 and 3/7 filling factors, identify CF states and look for factors responsible for their stability.

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