Fractional Chern insulator edges: crystalline effects and optical measurement

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Edge states of chiral topologically ordered phases are commonly described by chiral Luttinger liquids, effective theories that are exact only in the hydrodynamic limit. In crystalline systems, however, deviations from simple power-law scalings of correlators generally emerge. Motivated by recent bulk observations of fractional Chern insulators in two-dimensional materials, we revisit this framework and systematically quantify deviations from the hydrodynamic limit due to lattice effects. Using a combination of analytical arguments and numerical simulations, we extract the anomalous boundary exponent from correlation functions—showing that it robustly tracks the bulk filling factor—while independently determining non-universal edge velocities and associated energy scales from short-time dynamics. Applied across integer and fractional Chern insulators in bands with realistic Berry-curvature inhomogeneity, our procedure provides stable estimators that connect edge responses to bulk topology beyond the flat-band limit. Finally, we propose experimental probes of excitonic fractional Chern insulators, whose charge-neutral nature hinders conventional detection. In particular, time-resolved edge spectroscopy provides direct access to the predicted exponents and velocities, offering a viable route to identifying these phases.

[1] https://arxiv.org/abs/2511.17494.