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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, an effective theory that is exact only in the conformal limit; but in crystalline systems, deviations from simple power-law scaling of correlators generally emerge. Motivated by recent bulk observations of fractional Chern insulators in two-dimensional materials, we revisit this framework on lattices and quantify departures from the fractional quantum Hall case arising from lattice geometry. Using a combination of analytical arguments and numerics, including time-dependent matrix product state simulations, we separate universal and non-universal edge information. From correlation functions, we extract the anomalous boundary exponent, which tracks the bulk filling factor, and independently determine the non-universal edge velocity and associated energy scales from short-time dynamics. Applied across integer and fractional Chern bands with realistic Berry-curvature inhomogeneity, our procedure provides stable estimators that connect edge responses to bulk topology beyond the flat-band limit. We outline experimental probes in excitonic FCIs, including time-resolved edge spectroscopy, which directly access the predicted exponents and velocities.

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