Quantum geometry adaptiveness and fractional Chern insulators in non-Chern flat bands

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The fractional quantum Hall effect was initially discovered in a two-dimensional electron gas subjected to a strong magnetic field, which quantizes the kinetic energy of the electrons into discrete, highly degenerate Landau levels (LL). Its extension beyond the LL paradigm was first made possible by noting the topological equivalence of Chern bands in crystals to LLs, which can be further engineered in the isolated flat band limit
to mimic LLs both in energy landscape and in quantum geometry. This has led to the ground breaking discovery of fractional Chern insulators at zero magnetic field. We will discuss possibilities to go beyond the Chern band and LL paradigm, and present findings in lattice models that demonstrate fermionic and bosonic Laughlin and Moore-Read states in exact flat bands where band topology is trivial, critical, or ill-defined [1-4]. A key observation underlying these expected emergence of the fractional states is that the interacting carriers in the flat band can self-adapt to the quantum metric landscape, tending to occupy regions with favorable quantum geometry, albeit the trivial or ill-defined band topology.

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