Quantum Hall effect and Landau levels without spatial long-range correlations

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The spectrum of charged particles in translation-invariant systems in a magnetic field is characterized by the Landau levels, which play a fundamental role in the thermodynamic and transport properties of solids. The topological nature and the approximate degeneracy of the Landau levels are known to also survive on crystalline lattices with discrete translation symmetry when the magnetic flux through a primitive cell is small compared to the flux quantum. Here we show that the notion of Landau levels and the quantum Hall effect can be generalized to 2d non-crystalline lattices without spatial long-range order. Remarkably, even when the spatial correlations decay over microscopic distances, 2d systems can exhibit several well-resolved Landau-like bands. The existence of these bands implies that non-crystalline systems in magnetic fields can support the hallmark quantum effects which have been typically associated with crystalline solids.

References

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