Strongly interacting lattice fermions with synthetic dimensions: from universal Hall response to Hall voltage measurement

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We report on the first quantum simulation of the Hall effect for strongly interacting fermions [1]. By performing direct measurements of current and charge polarization in an ultracold-atom simulator, we trace the buildup of the Hall response in a synthetic ladder pierced by a magnetic flux, going beyond stationary Hall voltage measurements in solid-state systems. We witness the onset of a clear interaction-dependent behavior, where the Hall response deviates significantly from that expected for a non-interacting electron gas, approaching a universal value [2]. Our system, able to reach hard to compute regimes also demonstrates the power of quantum simulation for strongly correlated topological states of matter.

By further applying an additional potential gradient along the synthetic dimension, we have implemented the first measurement of the Hall voltage [3] in an atomic quantum simulator with strongly interacting ultracold fermions, and performed a systematic study of the Hall voltage as a function of the atom number. The observed sole dependence on particle fillings and remarkable robustness with respect to ladder geometries will enable new investigations of the exotic transport properties in the strongly correlated regime.

References

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