Observation of universal Hall Response in strongly interacting fermions

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Abstract

The Hall effect, which originates from the motion of charged particles in a magnetic field, has profound consequences for the description and characterization of materials, extending far beyond the original context of condensed matter physics. Although the Hall effect for non-interacting particles is well understood also in the quantum regime, understanding the Hall effect in interacting systems still represents a fundamental challenge even in the classical, weak-field case. Here we directly observe how the Hall response [1,2] builds up in an interacting quantum system by exploiting controllable quench dynamics in an atomic quantum simulator. By tracking the motion of ultracold fermions in a synthetic ladder [3], we measure the Hall response depending on synthetic tunneling and atomic interactions, unveiling a universal behavior in the strongly interacting limit and exhibiting a clear agreement with theoretical analyses. We expect our findings to open new directions towards strongly correlated topological phases such as fractional quantum Hall states and spin liquids.

Reference

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