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Observation of Universal Hall Response in Strongly Interacting Fermions

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The Hall effect, which originates from the motion of charged particles in a magnetic field, has deep 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 explained, understanding it in interacting systems still represents a fundamental challenge even in the small-field case. Here [1] we directly observe the build-up of the Hall response in an interacting quantum system by exploiting controllable quench dynamics in an atomic quantum simulator. By tracking the motion of ultracold fermions in a two-leg ribbon threaded by an artificial magnetic field, we measure the Hall response as a function of synthetic tunnelling and atomic interactions. We unveil an interaction-independent universal behaviour above an interaction threshold, in clear agreement with theoretical analyses [2-3]. Our approach and findings open new directions for the quantum simulation of strongly correlated topological states of matter.

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[1] To appear in Science, arXiv:2205.13567
[2] Universal Hall Response in Interacting Quantum Systems, S.
Greschner, M. Filippone and T. Giamarchi, Phys. Rev. Lett. 122, 083402 (2019).
[3] Vanishing Hall Response of Charged Fermions in a Transverse Magnetic Field, M. Filippone, C.-E. Bardyn.
S. Greschner, T. Giamarchi, Phys. Rev. Lett. 123, 086803 (2019).

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