Observation of Universal Hall Response in Strongly Interacting Fermions

Michele Filippone*[1], Tianwei Zhou , Daniele Tusi , Lorenzo Franchi , Jacopo Parravicini , Cecile Repellin , Sebastian Greschner , Massimo Inguscio , Giacomo Cappellini , Thierry Giamarchi , Jacopo Catani , and Leonardo Fallani

[1]CEA Grenoble – CEA IRIG-MEM : L$_{S}im - -France$

Abstract

The Hall effect originates from the motion of charged particles in a magnetic field and has deep consequences for the description and characterization of materials, far beyond the context of condensed matter physics. Understanding the Hall effect in interacting systems still represents a fundamental challenge. 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, see Figure 1. 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. (1) T. Zhou, D. Tusi, L. Franchi, J. Parravicini, C. Repellin, S. Greschner, M. Inguscio, G. Cappellini, T. Giamarchi, **M. Filippone**, J. Catan and L. Fallani. Observation of Universal Hall Response in Strongly Interacting Fermions, arXiv:2205.13567, to appear in **Science**.
(2) S. Greschner, **M. Filippone** and T. Giamarchi, Universal Hall Response in Interacting Quantum Systems, **Phys. Rev. Lett. 122, 083402** (2019).
(3) **M. Filippone**, C.-E. Bardyn. S. Greschner and T. Giamarchi, Vanishing Hall Response of Charged Fermions in a Transverse Magnetic Field, **Phys. Rev. Lett. 123**, 086803 (2019).

*Speaker