Institut für Angewandte Physik

Physikalisches Institut

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COLLOQUIUM „OPTICS AND CONDENSED MATTER“

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Quantum Hall states with rotating atoms – a voyage into the vortex

The fractional quantum Hall effect exhibits topologically ordered phases of matter resulting from the interplay of strong magnetic fields and interactions – many of which are famously described by Laughlin's celebrated wavefunction. Ultracold neutral atoms in synthetic magnetic fields offer a promising platform to explore the microscopic origins of these states, thanks to their unparalleld control over interactions, as well as the manipulation and detection of individual particles.

Here, we showcase the realization of a Laughlin state with two rapidly rotating spinful fermions in an optical tweezer [1,2]. Utilizing our single-atom and spin-resolved imaging technique, we reveal its defining signature: suppression of inter-particle interactions due to a vortex distribution in the particles' relative motion. Building upon this work, we extend our system to larger particle numbers, realizing a two-component integer quantum Hall (IQH) state comprised of three fermions in each spin state. This brings us in reach of studying the emergence of quantum phase transitions between IQH states of weakly interacting fermions and FQH states of interacting bosons, enabled via a Feshbach resonance to tune the inter-particles interactions [3].

[1] P. Lunt et al. Phys. Rev. Lett. **133**, 25340 (2024)
[2] P. Lunt et al. Phys. Rev. A **110**, 063315 (2024)
[3] G. Möller et al. PRL **99,** 190409 (2007)

December 2nd, starting with discussion at 17:00 h, talk at 17:15 h, live IAP lecture hall or via Zoom
https://uni-bonn.zoom.us/j/98441612025?pwd=a01SSjlkY1Q3SDFhL09JQk1qc1V6dz09
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