Chern-number Measurement and Topological Charge Pumping with Ultracold Bosonic Atoms

Monika Aidelsburger

Max-Planck Institute for Quantum Optics, Ludwig-Maximilians University, Germany

***Email of Presenting Author: monika.aidelsburger@physik.uni-muenchen.de**

The non-trivial dynamics of electrons moving in periodic potentials subjected to large magnetic fields, such as the integer quantum Hall effect, has motivated several works on analog quantum simulations with ultracold atoms in optical lattices. In the presence of a large magnetic field the single-particle energy bands split into magnetic subbands. In the case of square lattices these are called Hofstadter bands. In general these bands exhibit non-trivial topological properties that are characterized by a topological invariant - the Chern number underlying the integer quantum Hall effect. After the successful realization of artificial magnetic fields in the laboratory, new experimental probes had to be developed to reveal the non-trivial topology of the bands. Here I report on measurements of the transverse Hall deflection of ultracold bosonic atoms in artificially generated Hofstadter bands, which together with band-population measurements, enabled an experimental determination of the Chern-number of the lowest band with good precision.

In the second part of my talk I will report on the realization of a topological charge pump based on a dynamically controlled optical superlattice potential. In contrast to classical transport, the amount of charge, which is transported after one pump cycle, is purely determined by the topology of the pump cycle, making it robust against perturbations. On a fundamental level, the quantized charge transport can be connected to the topological invariant that characterizes the pump cycle. In the experiment we directly observe the quantized deflection of the atomic cloud by taking in-situ images and demonstrate that the system undergoes a controlled phase transition in higher bands when tuning the superlattice parameters.