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Topology in Floquet engineered optical lattices

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Topological properties lie at the heart of many fascinating phenomena in solid-state systems such as quantum Hall systems or Chern insulators. The topology of the bands can be captured by the distribution of Berry curvature, which describes the geometry of the eigenstates across the Brillouin zone. Using fermionic ultracold atoms in a hexagonal optical lattice, we engineered the Berry curvature of the Bloch bands using resonant driving and show a full momentum-resolved state tomography from which we obtain the Berry curvature and Chern number (Science 352, 1091 (2016)).

Furthermore, we study the time-evolution of the many-body wavefunction after a sudden quench of the lattce parameters and observe the appearance, movement, and annihilation of vortices in reciprocal space. We identify their number as a dynamical topological order parameter, which suddenly changes its value at critical times. Our measurements constitute the first observation of a so called dynamical topological phase transition, which we show to be a fruitful concept for the understanding of quantum dynamics far from equilibrium (arXiv 1608.05616).

The talk will discuss general concepts of topology and dynamics of ultracold quantum gases in optical lattices.