

Beyond Standard Optical Lattices: Topological Insulators and Exotic Magnetism

W. Hofstetter, Goethe-Universität Frankfurt am Main

The last years have witnessed dramatic progress in experimental control and refinement of optical potentials for ultracold atoms. Major recent developments are the realization of synthetic gauge fields for neutral atoms, allowing the simulation of topologically nontrivial phases of matter, and the creation of frustrated lattice geometries such as triangular or Kagome. Particularly rich physics arises in the presence of multiple atomic species and strong interactions, which I will highlight for two different examples.

1) We consider a spinful and time-reversal invariant version of the Hofstadter problem which can be realized in ultracold atoms. In these experiments, an additional staggered potential and spin-orbit coupling are available. Without interactions, the system exhibits various phases such as topological and normal insulator, metal as well as semi-metal phases with two or even more Dirac cones. Using a combination of real-space dynamical mean-field theory and analytical techniques, we discuss the effect of on-site interactions and determine the corresponding phase diagram. Specifically, we investigate the stability of topological insulator phases in the presence of strong interactions.

2) We study Bose-Bose mixtures on a triangular lattice, where geometric frustration arises for asymmetric hopping. We map out a rich ground state phase diagram including xy-ferromagnetic, spin-density wave, superfluid, and supersolid phases.