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Interacting Fermions and Bose-Fermi mixtures in Optical Lattices¹

HENNING MORITZ, Institute of Quantum Electronics, ETH Zurich, CH-8093 Zurich, Switzerland

When fermionic atoms are placed in the focus of several interfering laser beams, they feel a periodic potential and behave very much like electrons in a solid. However, the properties of this synthetic material can be changed at will. Here, we report on the realization of a strongly interacting Fermi gas in a 3D optical lattice, which opens the way to study condensed matter physics with light and atoms. For instance, the Fermi surface of the fermions in the lattice can be imaged and a dynamical transition from a band insulating state to a conductive state observed. The focus of the talk we will be on the behaviour of the system with changing interaction. By accessing a Feshbach resonance, we have formed molecules in the optical lattice and studied interaction induced coupling between the lowest Bloch bands as well as low-dimensional interacting Fermi gases. Finally, experiments with an interacting Bose-Fermi mixture in the lattice will be presented.

¹In collaboration with Kenneth Günter, Yosuke Takasu, Thilo Stöferle, Michael Köhl and Tilman Esslinger, Institute of Quantum Electronics, ETH Zurich, CH-8093 Zurich, Switzerland.