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Atom chips: Microscopically engineered environments for ultracold gases

Microfabricating metallic structures onto semiconductor surfaces allows to manipulate cold atoms in complex trapping geometries in the vacuum only microns away from the surface. We will give examples of the wide range of experiments that have already been performed on such atom chips. In particular, we will focus on studies of one-dimensional Bose gases and describe routes to extend these experiments to multiply connected topologies where homogenous one- and two-dimensional systems with periodic boundary conditions can be realized.

The proximity of the atoms to the surface can not only be used for high-precision, highly spatially resolved atom manipulation, but the atoms can be exploited as a probe of the surface. We present a proof-of-principle experiment where cold atoms have been used as a microscopic field sensor. An extension of this scheme to semiconductor and magnetic surfaces is outlined with an ultimate goal of forming hybrid atom-surface quantum systems.

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