Design of a dressed ring trap for cold atoms

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Controlling the potential energy landscape and the internal dynamics of ultracold atomic ensembles is crucial for atomic quantum technologies. Recent theoretical [1] and experimental [2,3] works demonstrate that the required degree of control of both dynamical aspects can be achieved by combining inhomogeneous distributions of static magnetic field with radio-frequency (RF) or microwave (MW) fields.

In this work we describe a flexible and robust scheme that creates closed quasi-one-dimensional guides for ultracold atoms through the ‘dressing’ of hyperfine sublevels of the atomic ground state with microwave radiation. In this scheme, the dressing field is spatially modulated by inductive effects over a micro-engineered conducting loop, which makes it compatible with atomchip technology, as in figure 1a. We present plans for an experimental realization of such a ring trap, integrating an atom-chip with miniaturised vacuum cells of cold atoms and a planar MW resonator (see figure 1b).

Atoms trapped in a closed loop can be exploited for rotational sensing [3]. However, such an application requires additional manipulation of the atomic states as well as the capability of controlled state-dependent transport. We outline several set-ups where these two elements can be incorporated by driving the dressed atoms with a second oscillating field.

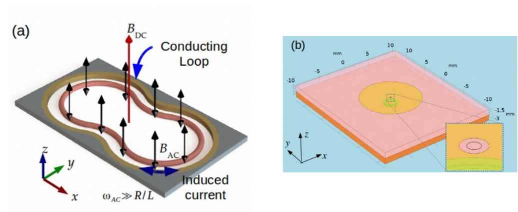

Figure 1. (a) Schematic of the working principle of a MW-dressed ring trap for cold atoms (b) Design of an atomchip realization of the ring trap.

Overall, we identify advantages and challenges of using low-frequency electromagnetic radiation for accurate control of ultracold atomic ensembles.

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[2] A. Smith. *et al*, Phys. Rev. Lett. **111**, 170502 (2013).

[3] G.A. Sinuco-Leon, *et al.*, Nat. Comm. **5**, 5289 (2014), G. A. Sinuco-Leon and B.M. Garraway, New J. Phys. **18**, 035009 (2016).