Tightly confining optical surface trap

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Our gravito-optical surface trap (GOST) provides easy access to large and dense samples of cesium atoms close to an evanescent-wave atom mirror. It can serve as an excellent starting point for loading further optical surface trapping schemes. We have realized a tightly confining surface trap by focussing a Nd:YAG laser beam (waist $30\,\mu$m) to the middle of the trapped atoms (Fig.1) providing a two dimensional gaussian potential. In vertical direction the atoms are trapped by gravitation and an evanescent wave (EW).

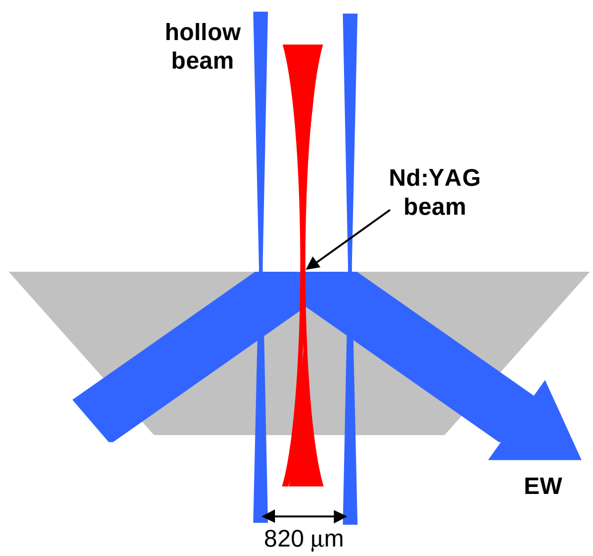

Figure 1: Illustration of the microtrap configuration. The hollow beam holds the reservoir whereas the far red-detuned Nd:YAG laser creates the microtrap potential.

In this scheme we can trap 1.5×10^5 cesium atoms in a volume of $2100\,\mu\mathrm{m}^3$, the achieved temperature is about $2.9\,\mu$K. Efficient loading of the fully conservative trap is provided by elastic collisions from a reservoir of optically and evaporatively precooled atoms in the GOST [1]. Through this mechanism the "dimple trap" [2] leads to a local increase of number and phase space density by more than two orders of magnitude. We achieve a peak-number density of $7 \times 10^{13}\,\mathrm{cm}^{-3}$ and a peak phase space density of 7×10^{-3}. With these conditions one finds the elastic collision rate to be as high as 1 kHz. Consequently after loading the microtrap and removing the atomic reservoir we start ramping down the microtrap potential to evaporatively cool the atomic sample. An initially efficient and fast evaporation on a timescale of about 100 ms is interrupted by strong losses due to inelastic collisions when the phase space density reaches about 1/50. However so far all evaporative cooling has been done on an unpolarized atomic sample. We expect evaporation to proceed to higher phase-space density as one uses polarized atoms.

In the near future we intend to investigate 2D quantum degenerated gases in a double-evanescent-wave trap [3]. This 2D-microtrap will be loaded by thermalization processes as demonstrated in the red detuned trap.

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[1] M. Hammes *et al.* J. Mod. Opt. **47**, 2755, (2000).
[2] D.M. Stamper-Kurn *et al.*, Phys.Rev. Lett. **81**, 2194, (1998).
[3] Yu. B. Ovchinnikov *et al.*, J. Phys. B. :At. Mol. Opt. Phys. **24**, 3173 (1991).