Interactions of Lithium Atoms in a Resonator-Enhanced Dipole Trap

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In order to study the interacting quantum gases of lithium atoms, we have developed a novel dipole trap based on the resonant enhancement of a far detuned standing wave in an optical resonator. Light from an ultrastable 2-W Nd:YAG laser is coupled into the resonator and enhanced 130-fold, thus creating a trap depth of ~1 mK for the lithium atoms. It enables us to trap ~$10^5$-$10^6$ laser-cooled atoms in ~1000 wells of the standing wave [1].

Fig. 1: Schematic of the resonator trap

Current experimental work is being performed with the fermionic isotope, $^6$Li. The goal is to explore a Feshbach resonance that is predicted at a magnetic field of 800 G [2]. In following experiments, the tunability of the interactions in the vicinity of this resonance will be essential to accelerate thermalization of the trapped gas, which is essential for a variety of cooling techniques [3]. Also, a strongly attractive interaction will be necessary to observe a phase transition to a BCS phase at an experimentally feasible temperature.

The diode laser system used for the magneto-optical trap can be easily adapted to trap the bosonic isotope, $^7$Li. With the bosons we plan to explore combinations with magnetic traps [4], a novel collision-assisted cooling scheme [5], and the production of a stable array of small attractively interacting Bose-Einstein condensates.