Rapid production of uniformly filled arrays of neutral atoms

Introduction

• Near-deterministic loading of single $^{87}$Rb atoms in 2x2 array of optical tweezers

• More than 60% rate of success in maximum 4 atoms loading

• Smallest successful well spacing was 1.46 $\mu$m.
Highly focused tweezer

- Loading atoms by putting the array of tweezer in MOT cloud.
- After turning off MOT, only one atom can be loaded in one site with collisional beam.
- \((\lambda = 852 \text{ nm}, w_0 = 0.71 \mu \text{m})\)
Level structure of $^{87}\text{Rb}$

$^5\text{P}_{3/2}$

$|F'=0,1,2,3>$

D2 line for MOT ($\lambda=780\text{nm}$)

$^5\text{P}_{1/2}$

$|F'=1,2>$

D1 line for light-assisted collision ($\lambda=795\text{nm}$)

$^5\text{S}_{1/2}$

Optical tweezer ($\lambda=852\text{nm}$)

$|F=1,2>$
Light-assisted collisions

- As atoms approaches each other, D1 line laser is resonant with molecular potential.
- Repulsion or attraction occurs according to the detuning.
Light-assisted collisions

- Trap depth: $h \cdot 73$ MHz
- $\delta = 115$ MHz
- 2-2′ beam pumps trapped atoms to the $|F=1\rangle$ state.
Photon number histogram

- No single event 2 atoms in one site in 2000 experiments
- One atom prob. is $88.7 \pm 0.4\%$. 
Atom number probability

- Maximum loading probability is increased compared to previous experiment.
D1 laser detuning vs loading

- Green dashed line is trap depth.
- Detuning near trap depth is proper to give one atom energy for leaving the trap.
• Rapid increase as MOT density increases.
Tweezer spacing vs. loading

- Loading probability decreases as the barrier between wells is lowered.
- \((w_0 = 0.71 \, \mu m, \, a = 1.46\mu m)\)
Two trapped atoms

- Prepared Initially 2 atoms in right well.
감사합니다.
Setup

Top view

Side view

From optical rail

852 nm

780 nm

LP

PZT

Objective

Imaging+MOT

MOT

BOT

TOP

μW horn

f=15 cm

f=10 cm

λ/4

AB 1

AB 2

GT

NPBS

OP

EO

RP

Dichroic

glass

CCD

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