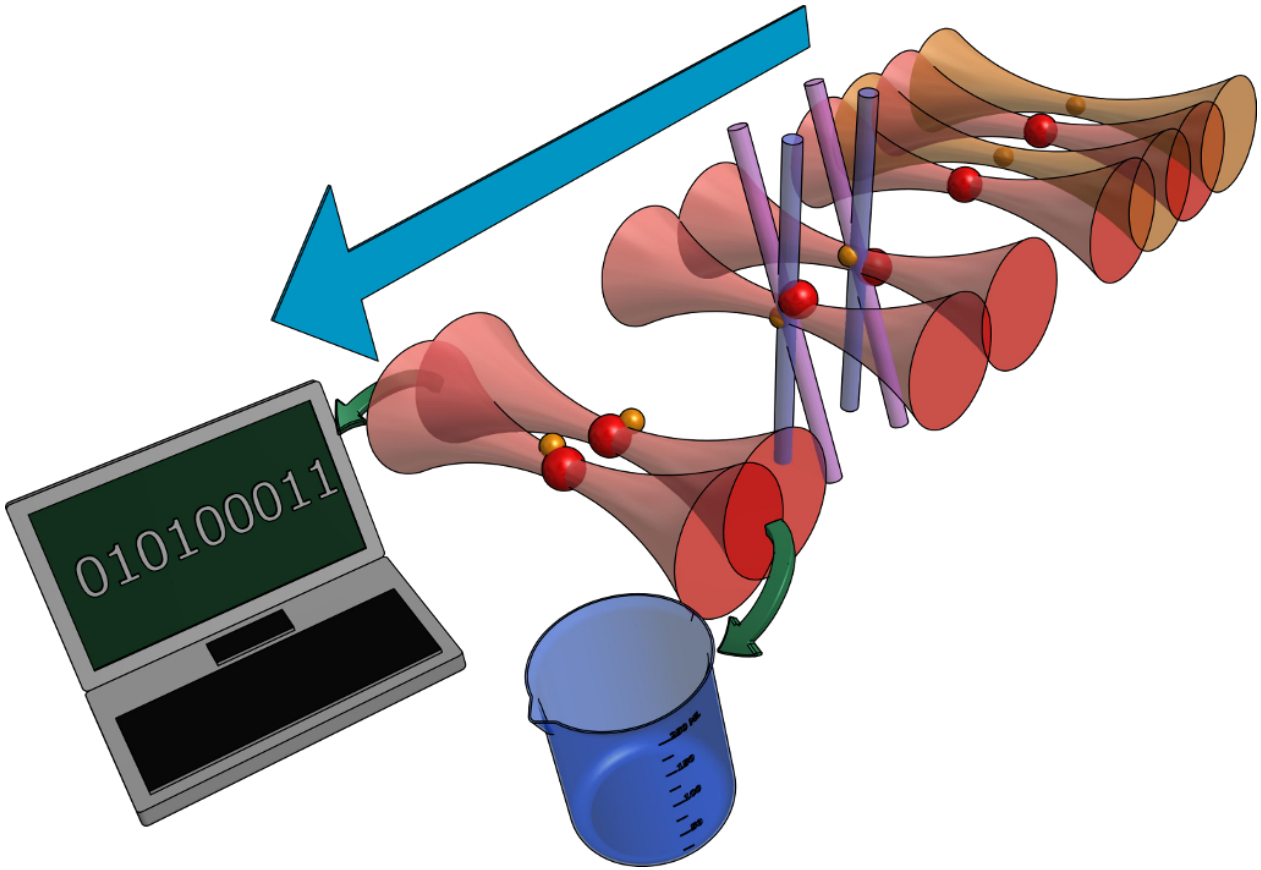
Trapping and imaging of single atom in the present of light shift



Yichao Yu
May 26, 2016
Ni Group/Harvard

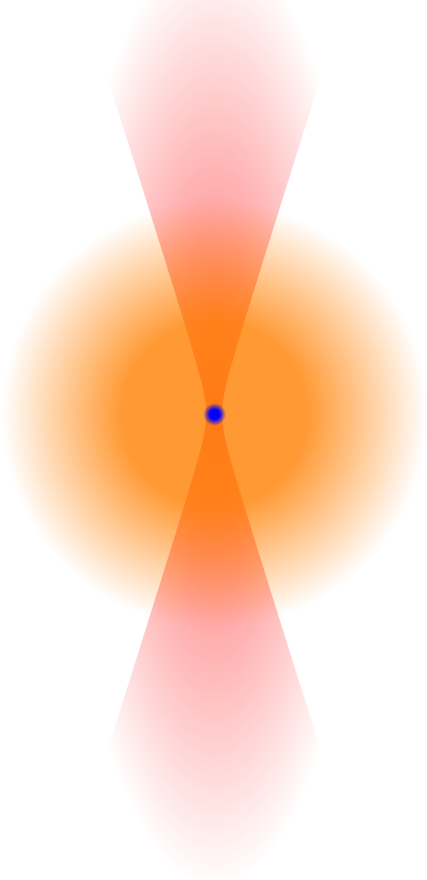
Procedure

- MOT Loading
- Trapping
- Imaging
- Works for Cs
- Doesn't work for Na

Procedure

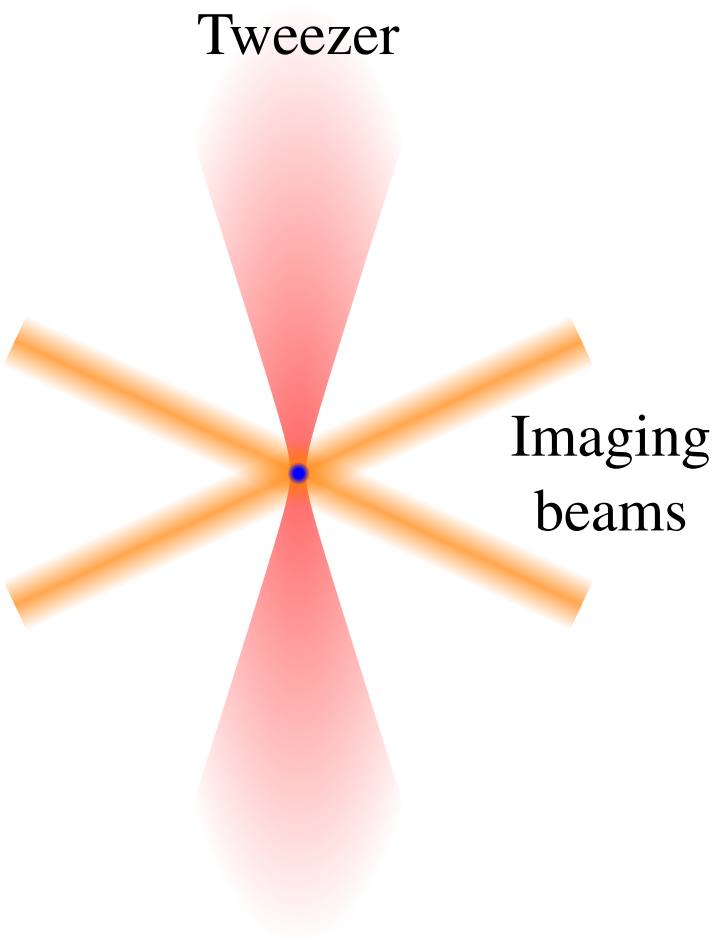
- MOT Loading
- Trapping
- Imaging
- Works for Cs
- Doesn't work for Na

Tweezer



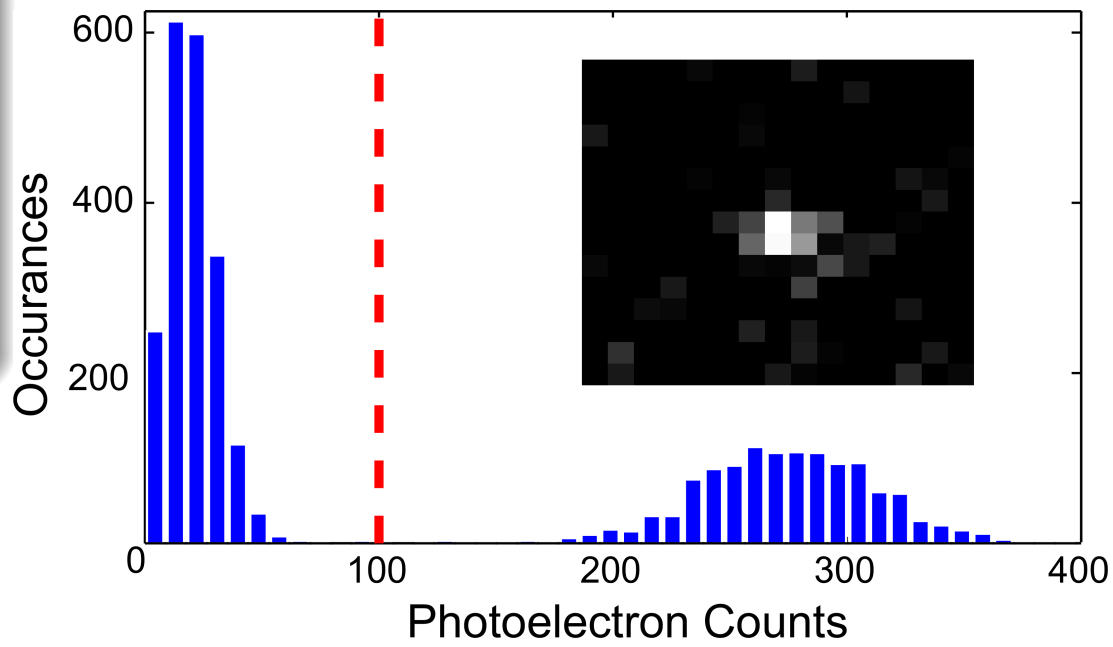
Procedure

- MOT Loading
- Trapping
- Imaging
- Works for Cs
- Doesn't work for Na



Procedure

- MOT Loading
- Trapping
- Imaging
- Works for Cs
- Doesn't work for Na

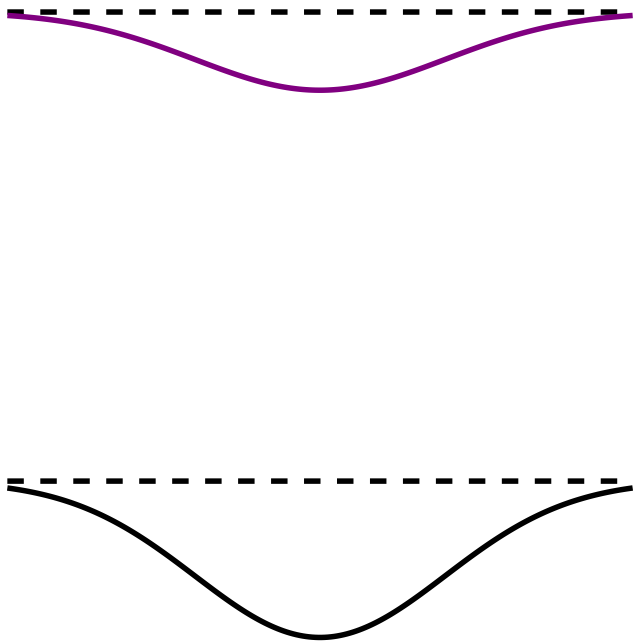


Procedure

- MOT Loading
- Trapping
- Imaging
- Works for Cs
- Doesn't work for Na

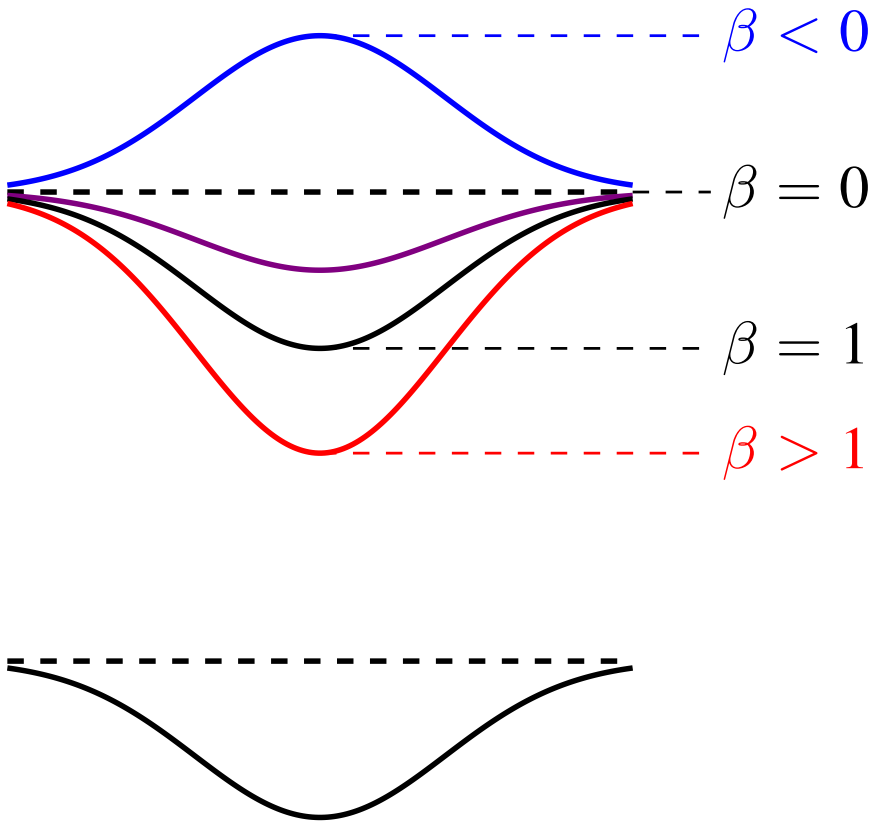
Light shift

- $\beta = \dfrac{\alpha_e}{\alpha_g}$
- Inefficient cooling; Heating
- Shift imaging light out of resonance



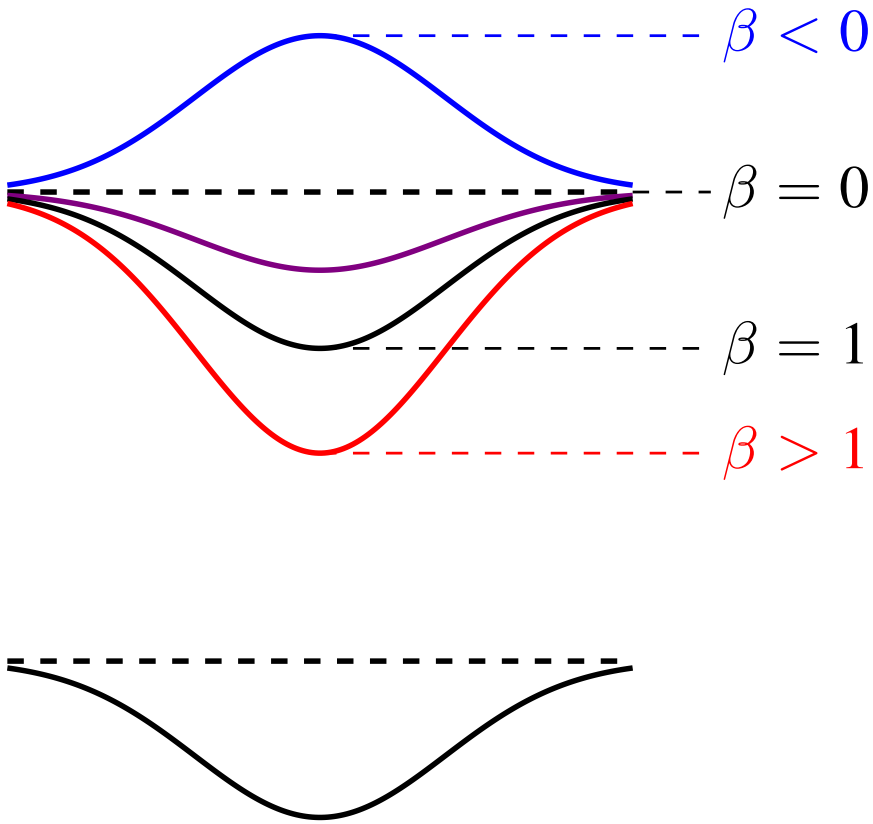
Light shift

- $\beta = \dfrac{\alpha_e}{\alpha_g}$
- Inefficient cooling; Heating
- Shift imaging light out of resonance



Light shift

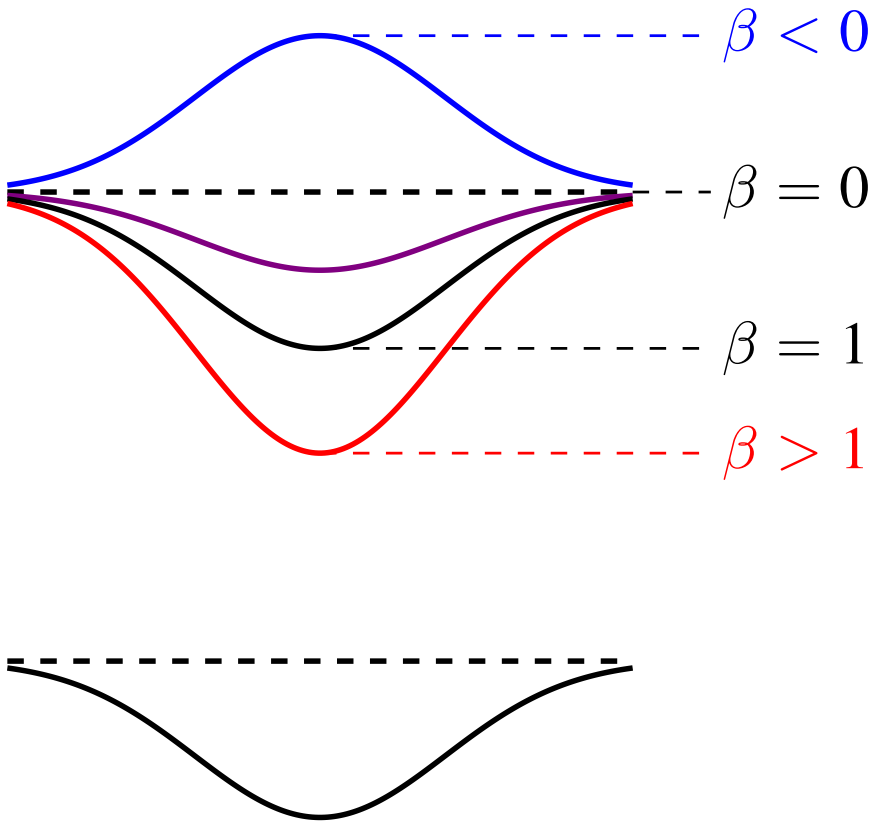
- $\beta = \dfrac{\alpha_e}{\alpha_g}$
- Inefficient cooling; Heating
- Shift imaging light out of resonance



Atom	Cs			Na
λ_{trap}	922	935	970	700
β_{cycle}	2	1	0.6	-1

Light shift

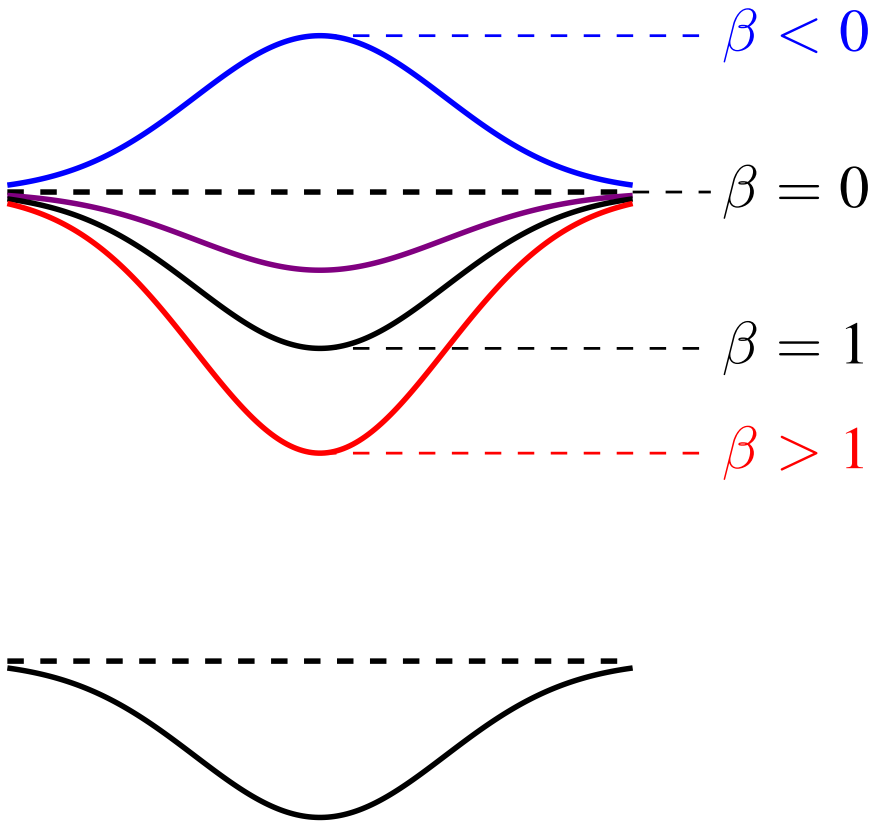
- $\beta = \dfrac{\alpha_e}{\alpha_g}$
- Inefficient cooling; Heating
- Shift imaging light out of resonance



Atom	Cs			Na
λ_{trap}	922	935	970	700
β_{cycle}	2	1	0.6	-1

Light shift

- $\beta = \dfrac{\alpha_e}{\alpha_g}$
- Inefficient cooling; Heating
- Shift imaging light out of resonance



Atom	Cs			Na
λ_{trap}	922	935	970	700
β_{cycle}	2	1	0.6	-1

Light shift

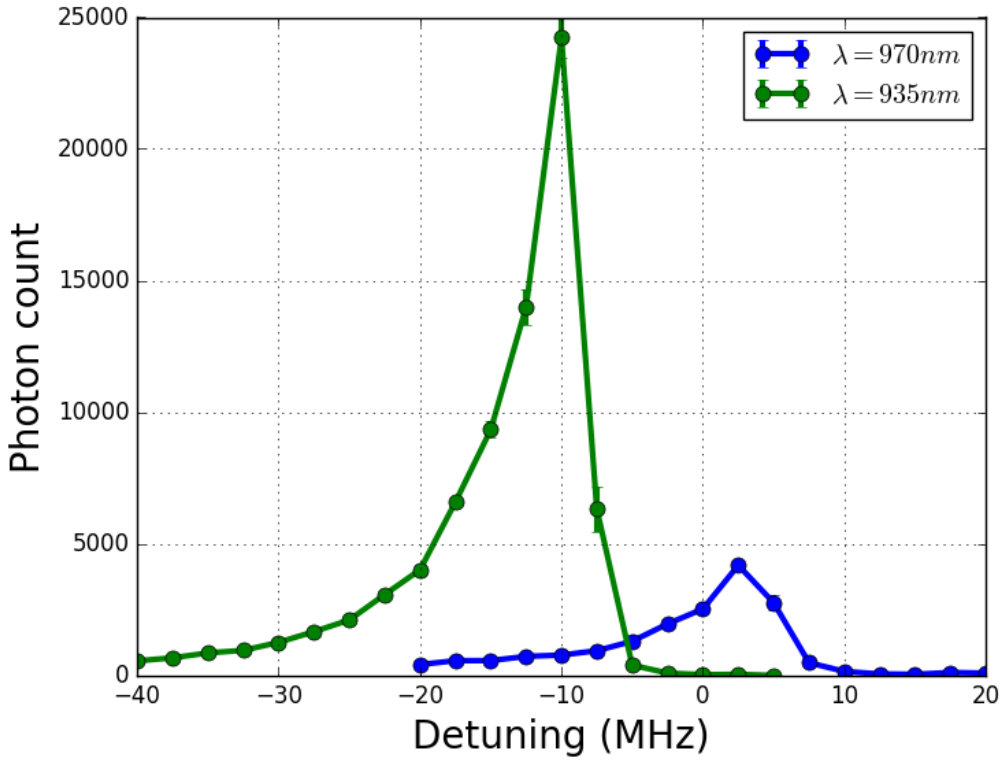
- $\beta = \dfrac{\alpha_e}{\alpha_g}$
- Inefficient cooling; Heating
- Shift imaging light out of resonance

Atom	Cs			Na
λ_{trap}	922	935	970	700
β_{cycle}	2	1	0.6	-1

Cs single atom loading

λ_{trap}	922	935	970
Loading %	0	≈ 50	≈ 50

Cs single atom imaging

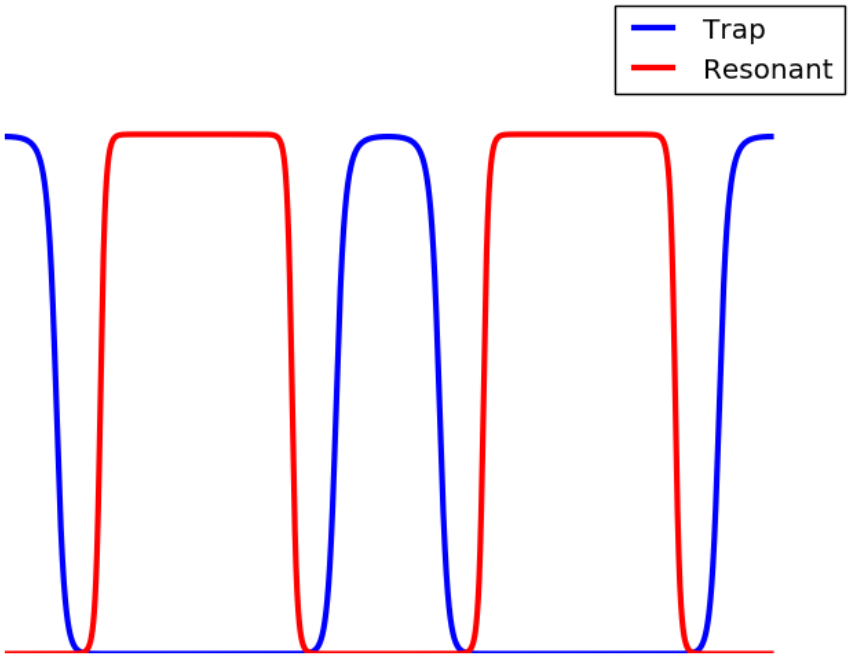


Trap switching

- Alternate between resonant and trap light
- Switching at $1 - 3$MHz
  $f_{trap} = 10 \sim 400$kHz
  $\Gamma = 2\pi \times 5 \sim 10$MHz
- Being able to load single Na atom

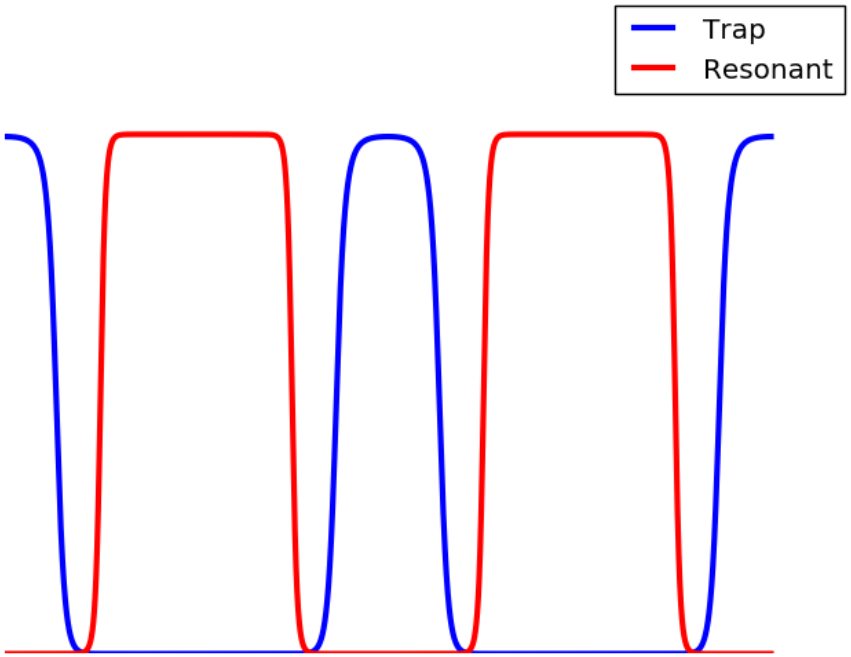
Trap switching

- Alternate between resonant and trap light
- Switching at $1 - 3$MHz
  $f_{trap} = 10 \sim 400$kHz
  $\Gamma = 2\pi \times 5 \sim 10$MHz
- Being able to load single Na atom



Trap switching

- Alternate between resonant and trap light
- Switching at $1 - 3\text{MHz}$
  $f_{trap} = 10 \sim 400\text{kHz}$
  $\Gamma = 2\pi \times 5 \sim 10\text{MHz}$
- Being able to load single Na atom

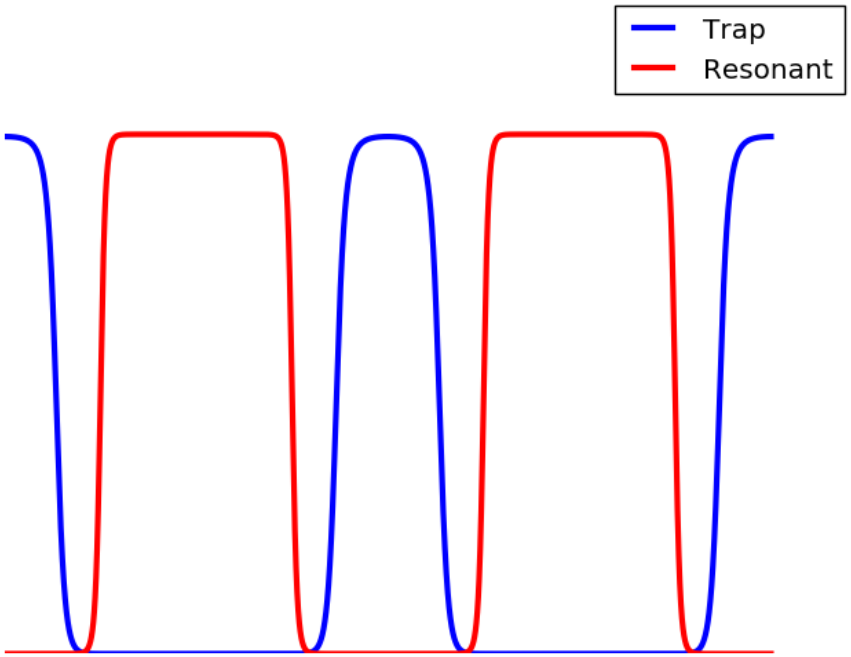


Trap switching

- Alternate between resonant and trap light
- Switching at $1 - 3$MHz
  $f_{trap} = 10 \sim 400$kHz
  $\Gamma = 2\pi \times 5 \sim 10$MHz
- Being able to load single Na atom

Cs single atom loading

λ_{trap}	922	935	970
Loading %	≈ 50	≈ 50	≈ 50



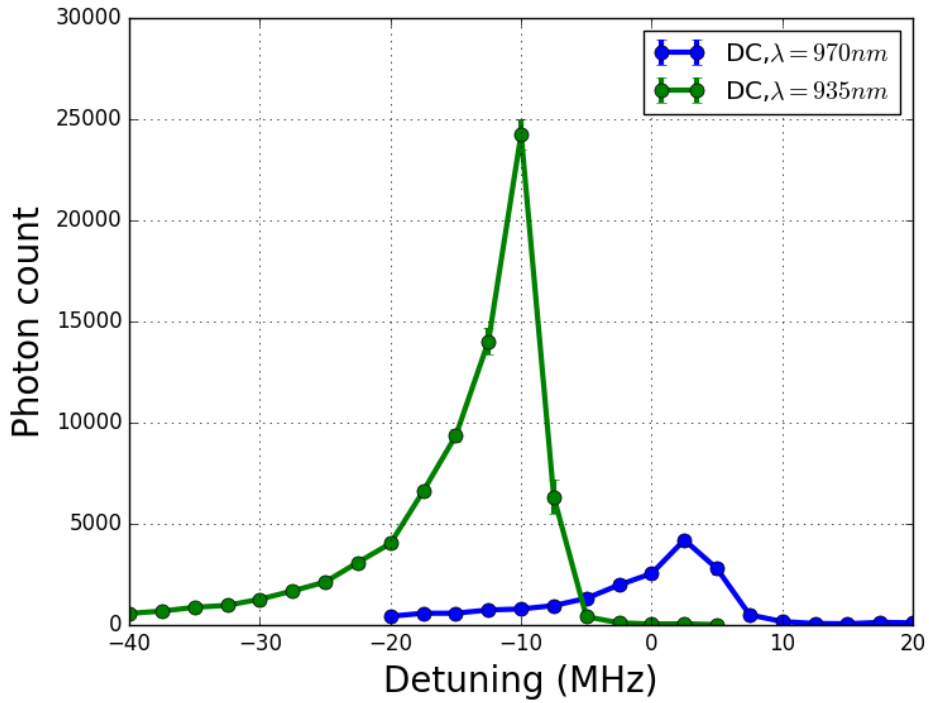
Trap switching

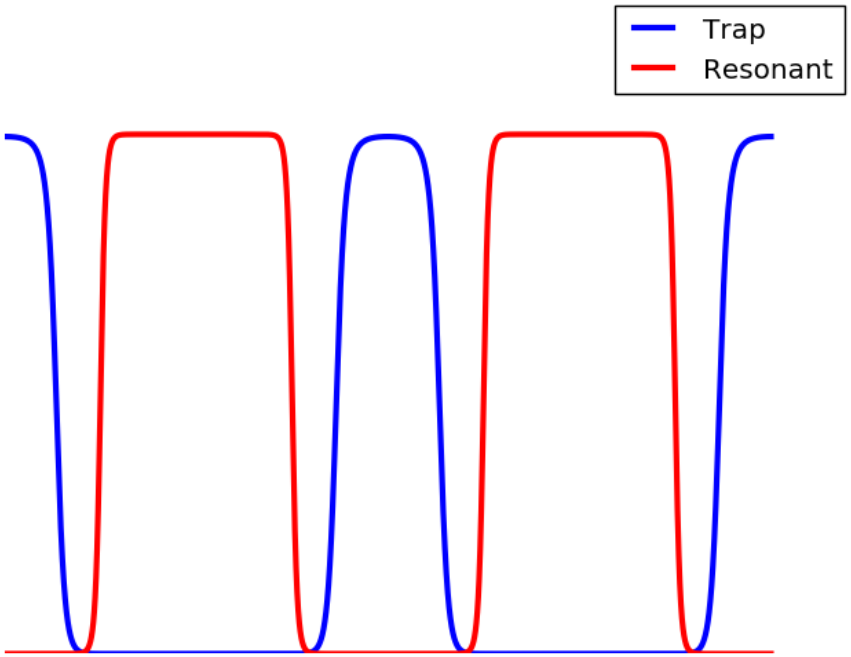
- Alternate between resonant and trap light
- Switching at $1 - 3$MHz
  $f_{trap} = 10 \sim 400$kHz
  $\Gamma = 2\pi \times 5 \sim 10$MHz
- Being able to load single Na atom

Cs single atom loading

λ_{trap}	922	935	970
Loading %	≈ 50	≈ 50	≈ 50

Cs single atom imaging





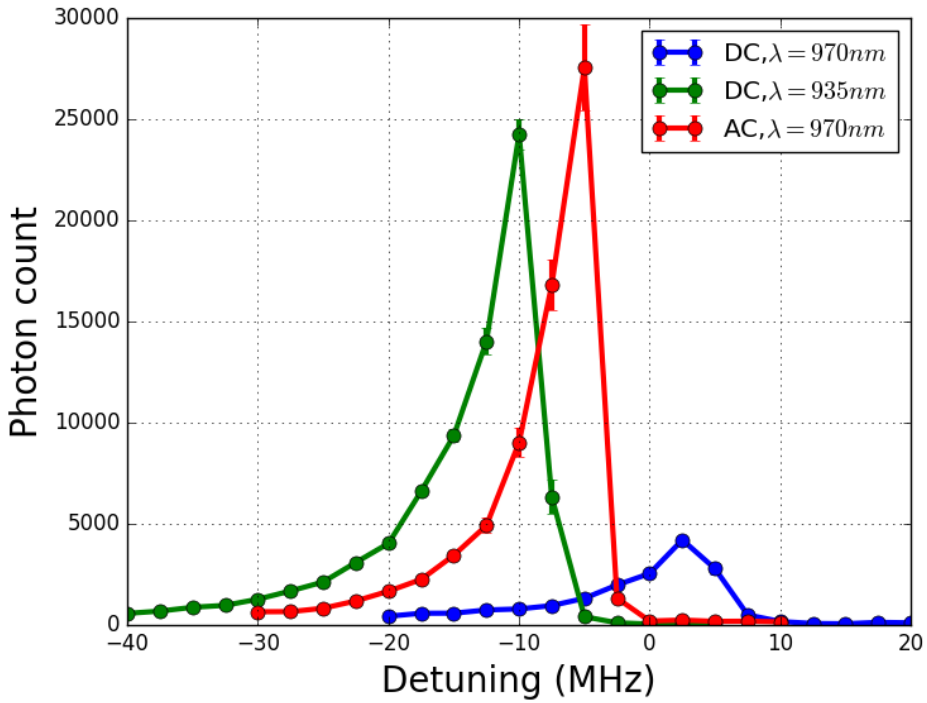
Trap switching

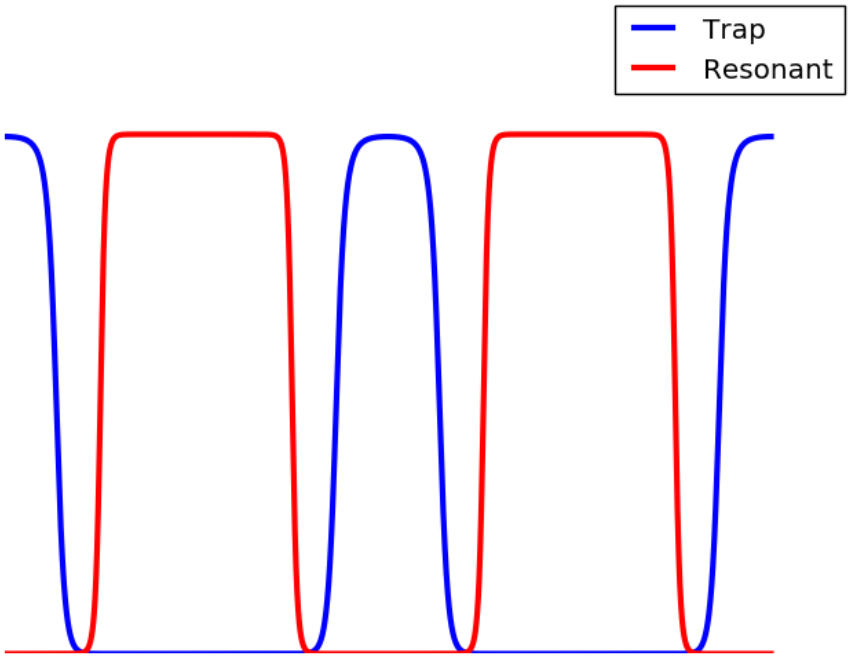
- Alternate between resonant and trap light
- Switching at $1 - 3$MHz
  $f_{trap} = 10 \sim 400$kHz
  $\Gamma = 2\pi \times 5 \sim 10$MHz
- Being able to load single Na atom

Cs single atom loading

λ_{trap}	922	935	970
Loading %	≈ 50	≈ 50	≈ 50

Cs single atom imaging





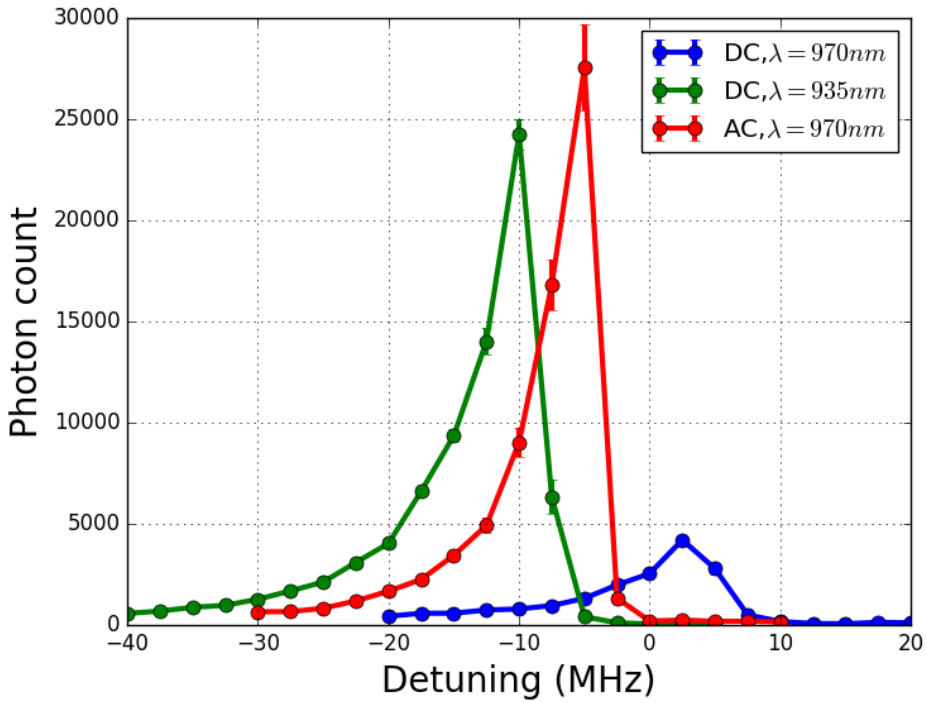
Trap switching

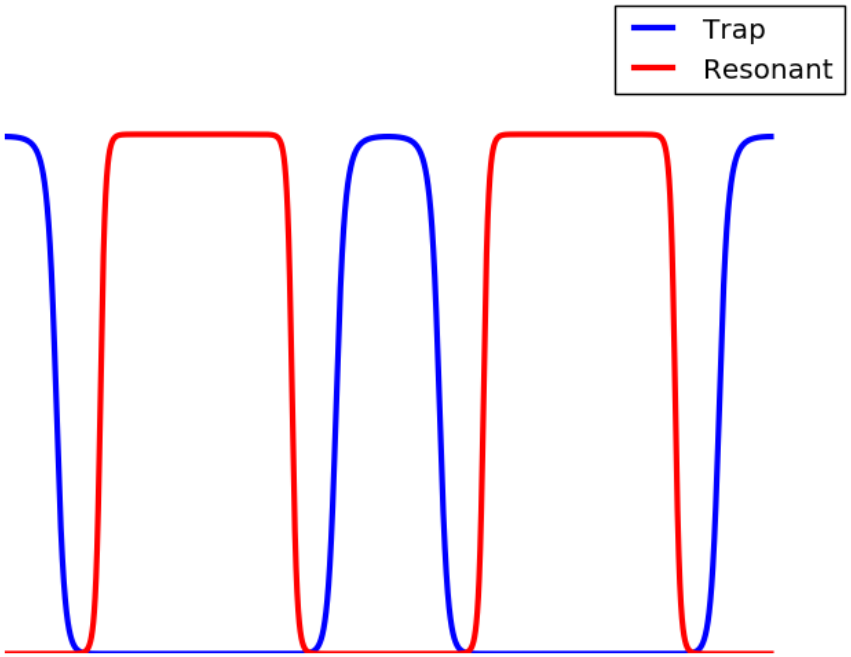
- Alternate between resonant and trap light
- Switching at $1 - 3$MHz
  $f_{trap} = 10 \sim 400$kHz
  $\Gamma = 2\pi \times 5 \sim 10$MHz
- Being able to load single Na atom

Cs single atom loading

λ_{trap}	922	935	970
Loading %	≈ 50	≈ 50	≈ 50

Cs single atom imaging





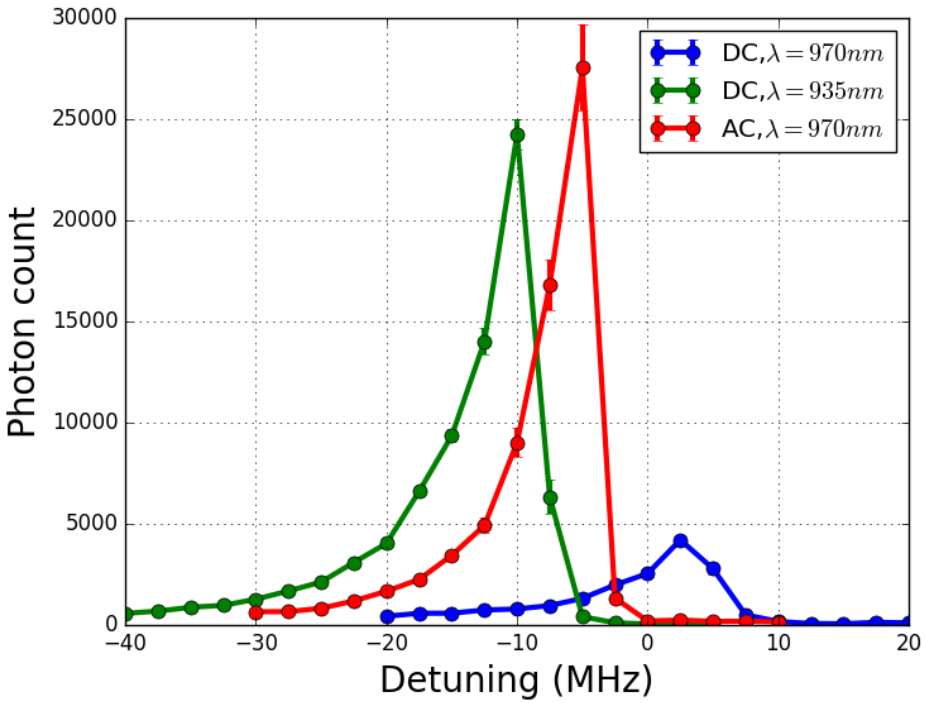
Trap switching

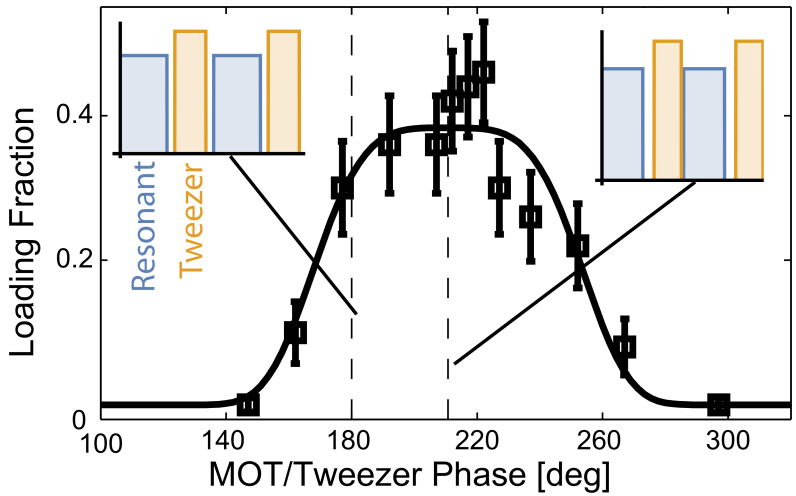
- Alternate between resonant and trap light
- Switching at $1 - 3$MHz
  $f_{trap} = 10 \sim 400$kHz
  $\Gamma = 2\pi \times 5 \sim 10$MHz
- Being able to load single Na atom

Cs single atom loading

λ_{trap}	922	935	970
Loading %	≈ 50	≈ 50	≈ 50

Cs single atom imaging





Conclusion

- Measured the effect of light shift on loading and imaging of single atom
- Overcome the light shift by alternating trapping and resonant light to achieve loading of single Na atom.
- Generalizable to other species