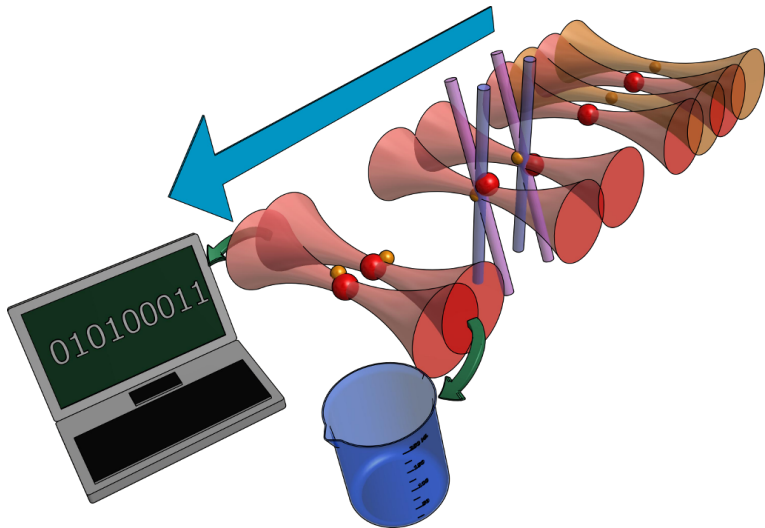


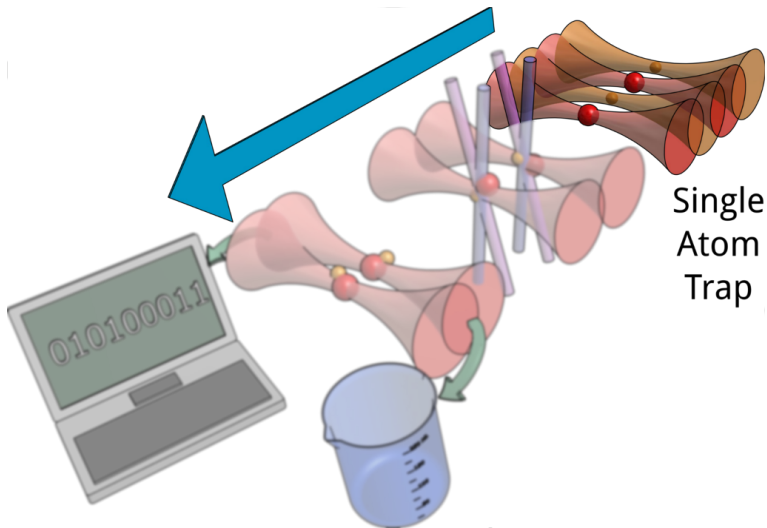
# Raman sideband cooling of single sodium atom to 3D ground state

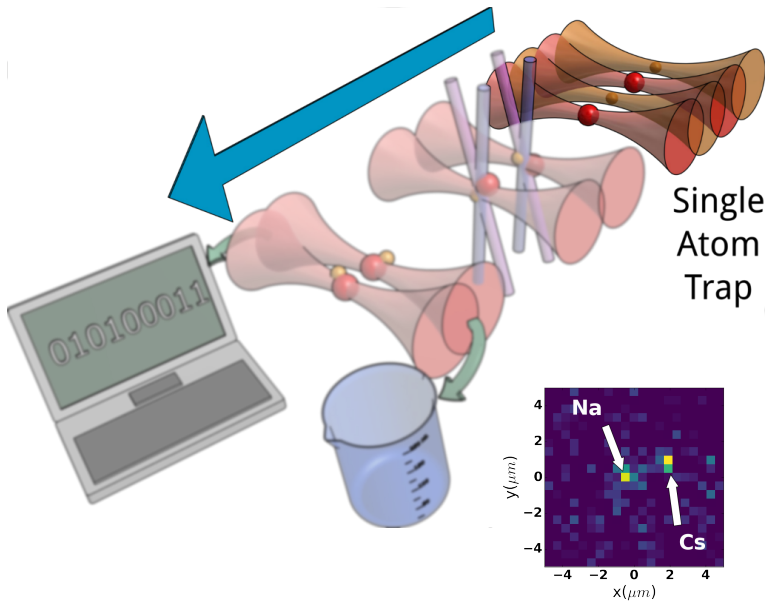
Yichao Yu

Ni Group/Harvard

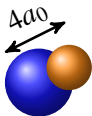
April 19, 2017



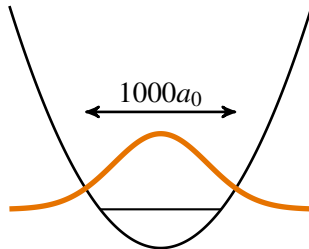




# Wave function size

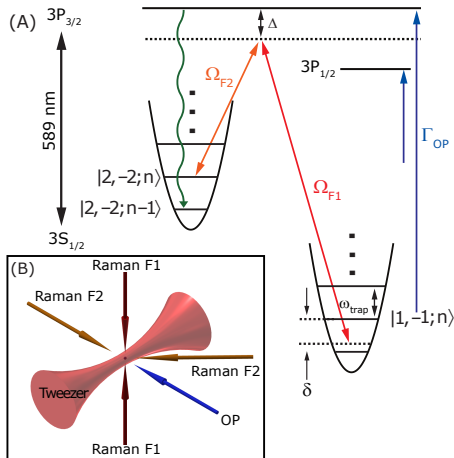


**Molecule**

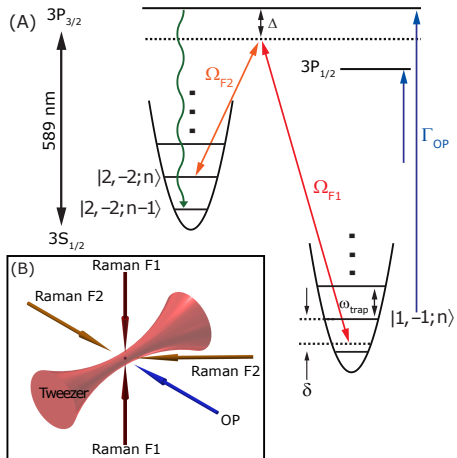


**Atom**

# Raman sideband cooling of Sodium



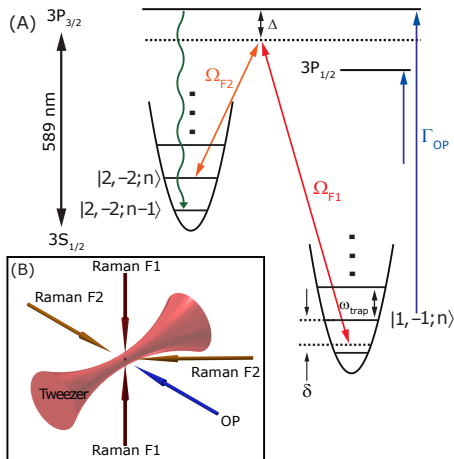
# Raman sideband cooling of Sodium



## Difficulties

- High initial temperature ( $40\mu K$ )
- High recoil heating

# Raman sideband cooling of Sodium

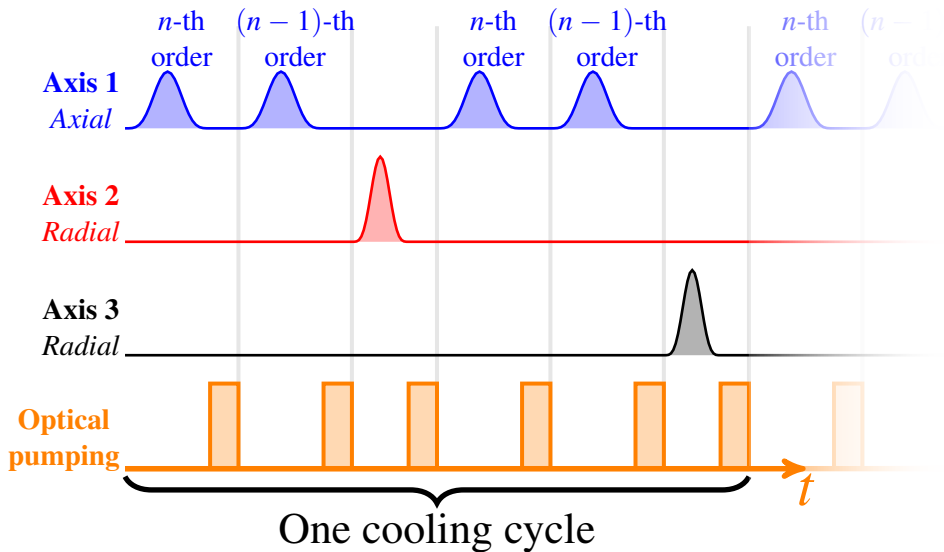


## Difficulties

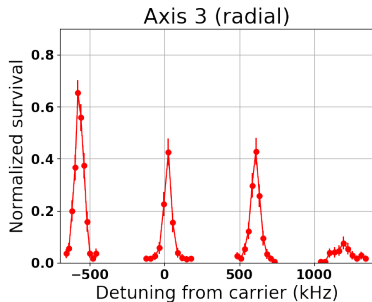
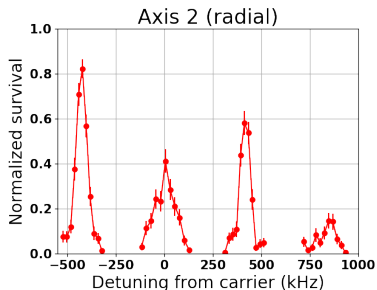
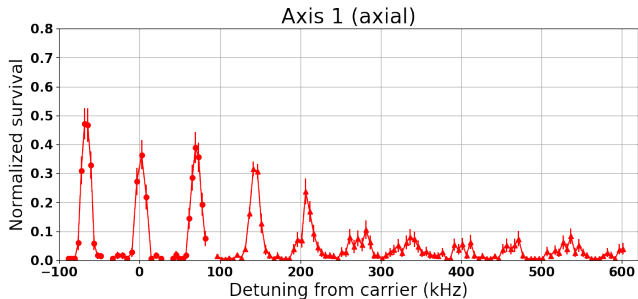
- High initial temperature ( $40\mu K$ )
- High recoil heating



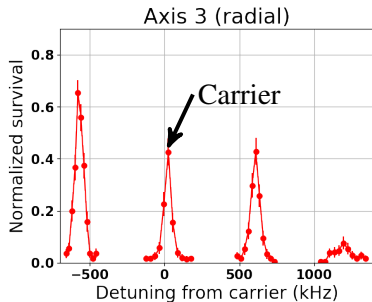
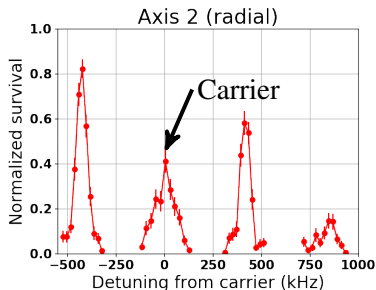
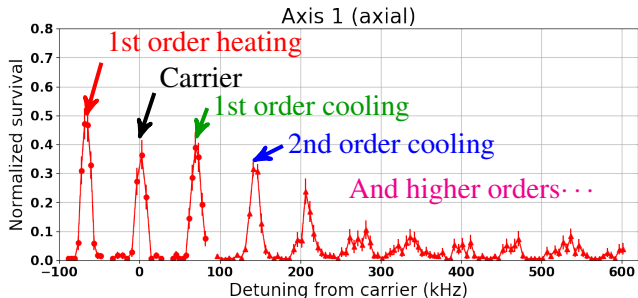
## Cooling sequence



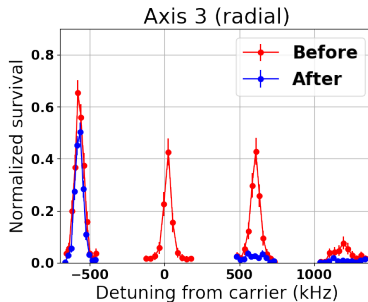
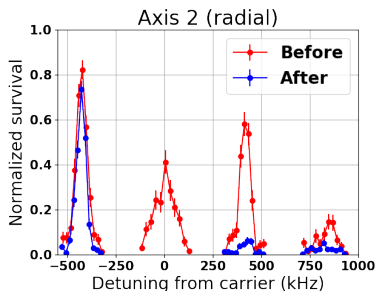
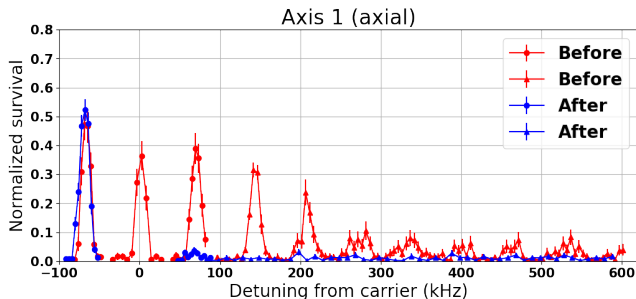
# Raman sidebands



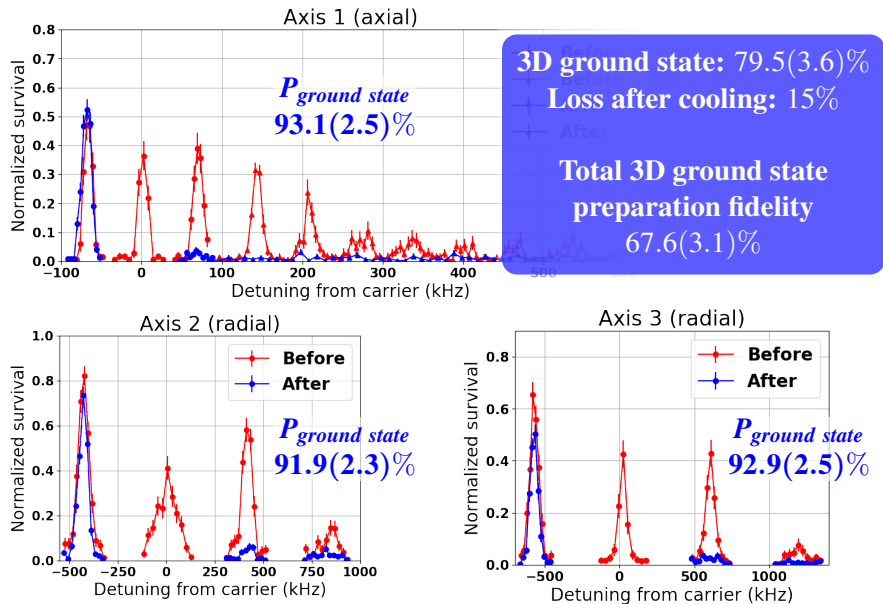
# Raman sidebands



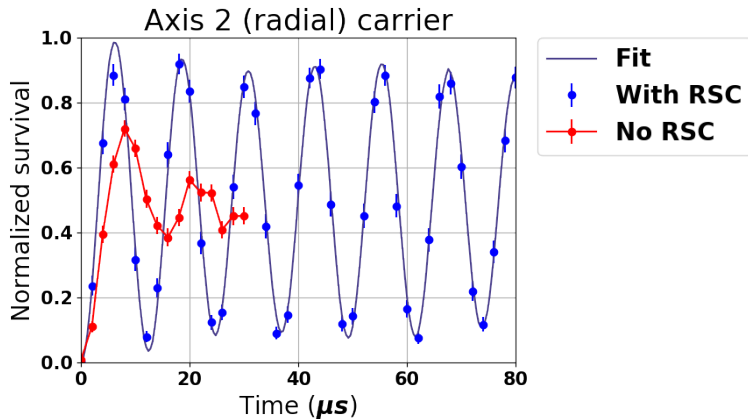
# Raman sidebands



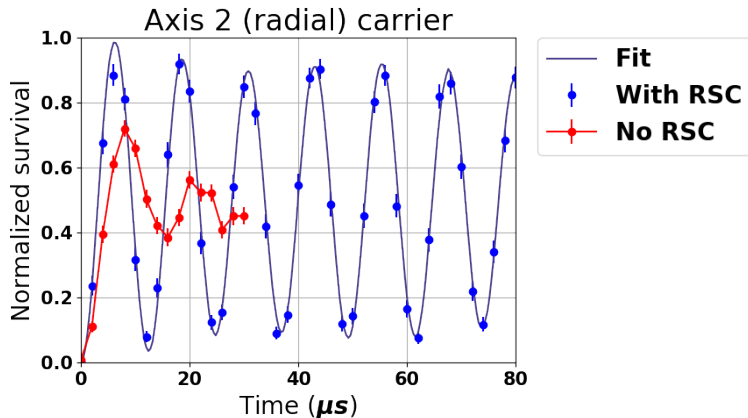
# Raman sidebands



## Rabi flopping (radial)

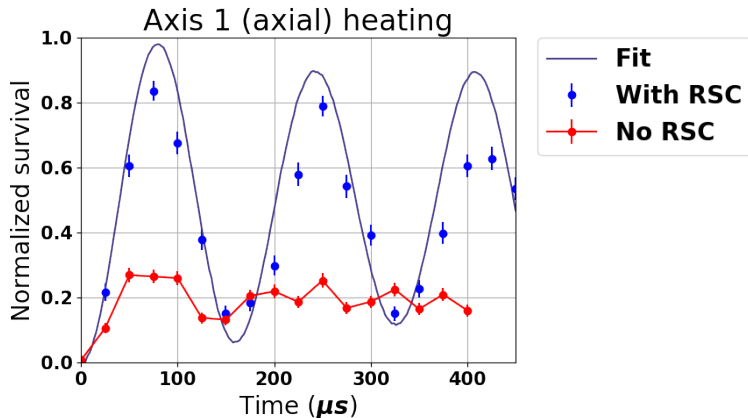


## Rabi flopping (radial)



Good agreement between spectrum and Rabi flopping data.

## Rabi flopping (axial)



Decoherence caused by magnetic field fluctuation.



## Conclusion

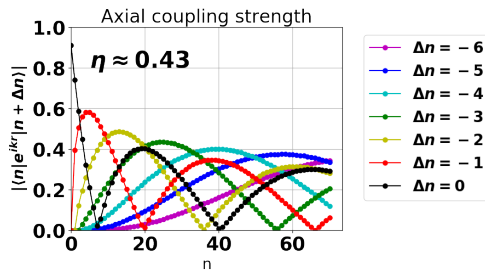
67.6(3.1)% ground state preparation fidelity (79.5(3.6)% without loss)

## Improvements

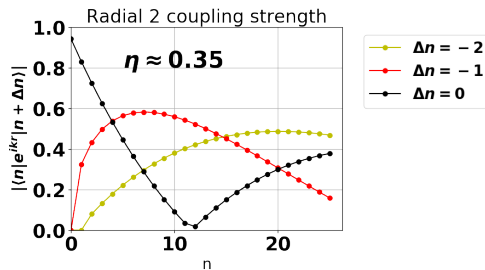
- Reduce off-resonance scattering from Raman beams
- Reduce magnetic field fluctuation
- Reduce loss during cooling



# Axial matrix element



## Radial 2 matrix element



# Radial 3 matrix element

