

# Association of single ultracold molecules in optical tweezers

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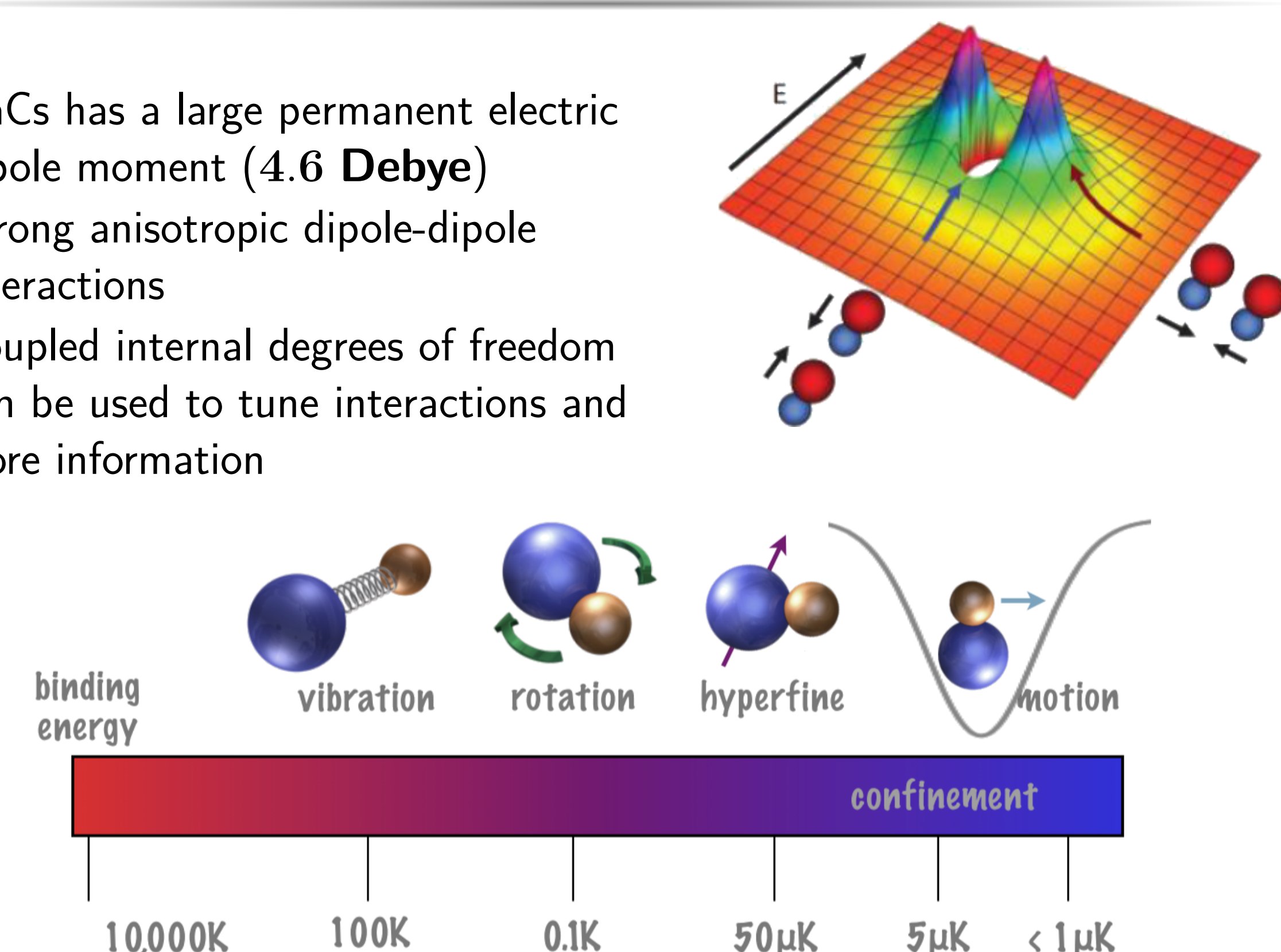
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## Ultracold Molecules

- NaCs has a large permanent electric dipole moment (4.6 Debye)
- Strong anisotropic dipole-dipole interactions
- Coupled internal degrees of freedom can be used to tune interactions and store information

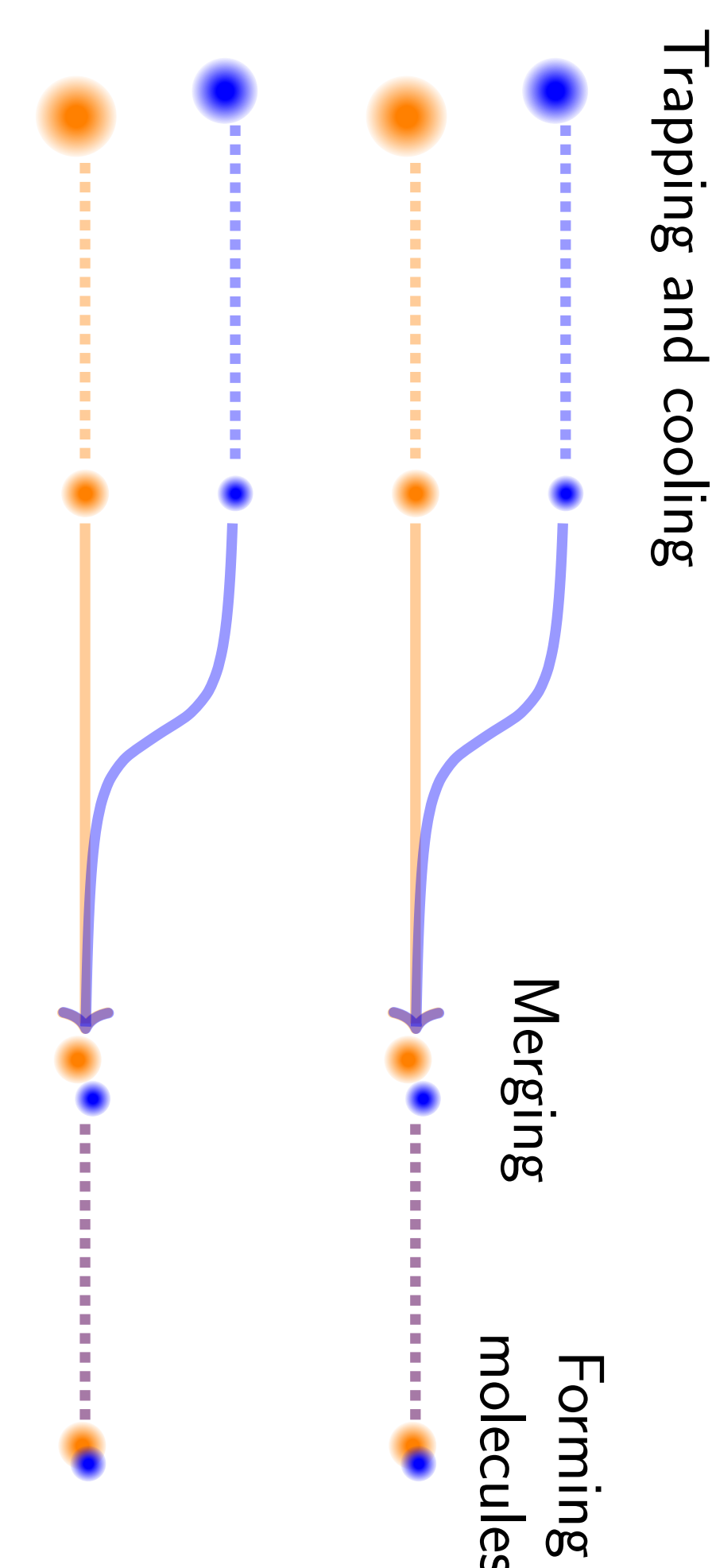


## Our Approach

- Assemble and trap individual molecules in optical tweezers from laser-cooled atoms
- Raman transition from atoms to weakly-bound molecules
- STIRAP to ground state molecules

### Advantages

- Fast cycle time (<1s), small vacuum chamber
- Dynamically configurable trapping geometry
- All optical cooling and state-manipulation

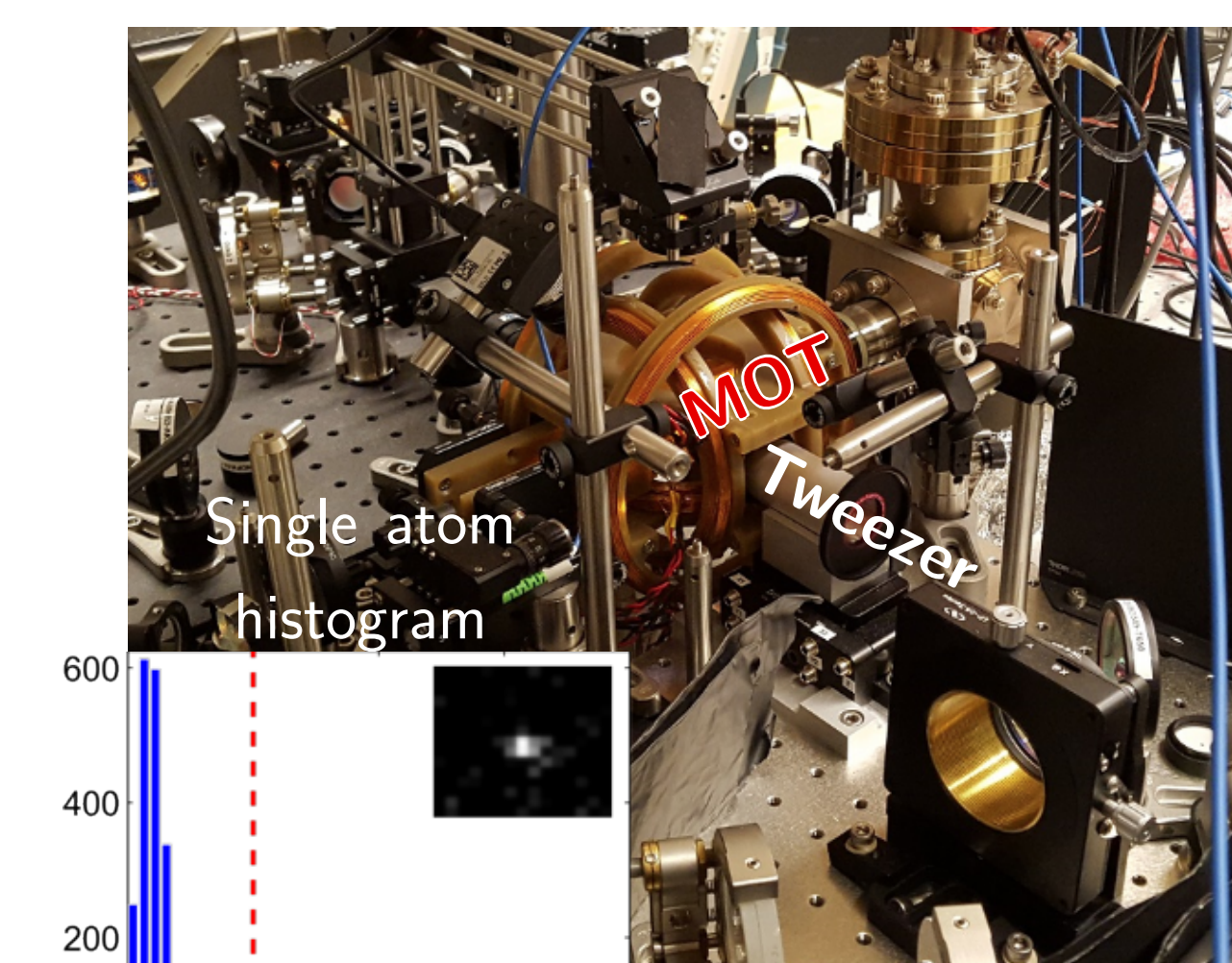
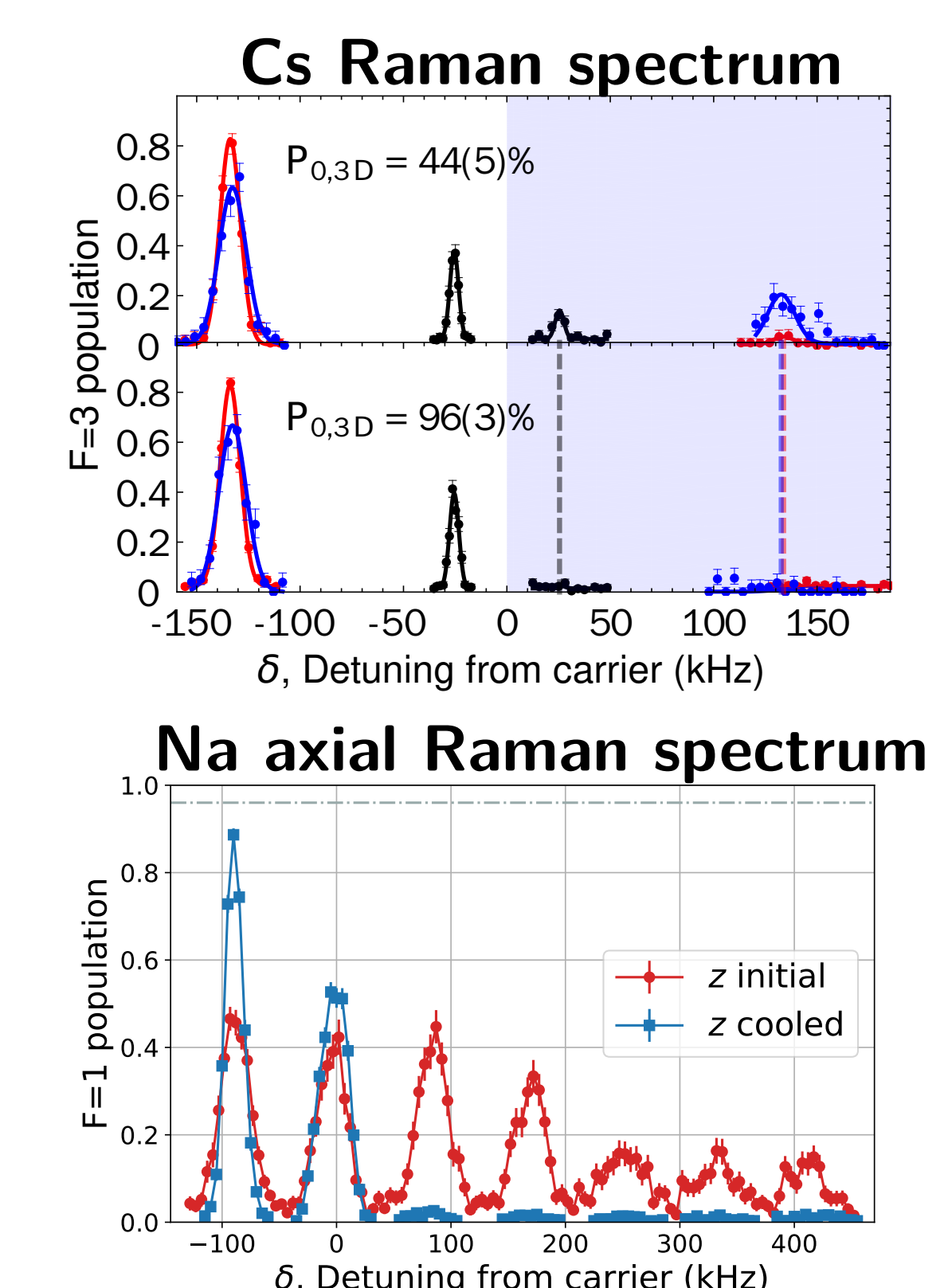
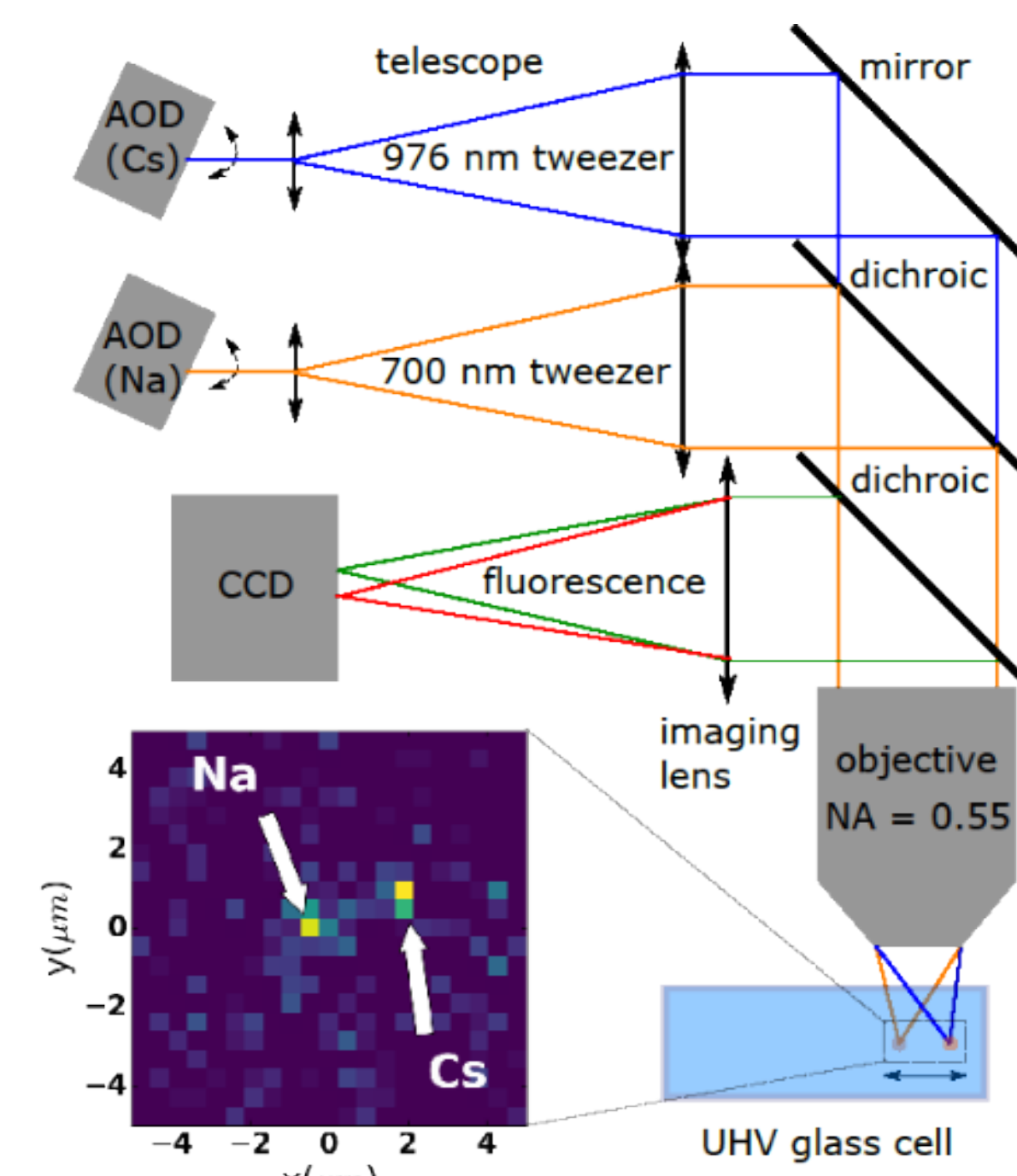


## Acknowledgements



## Trapping and Cooling of Atoms

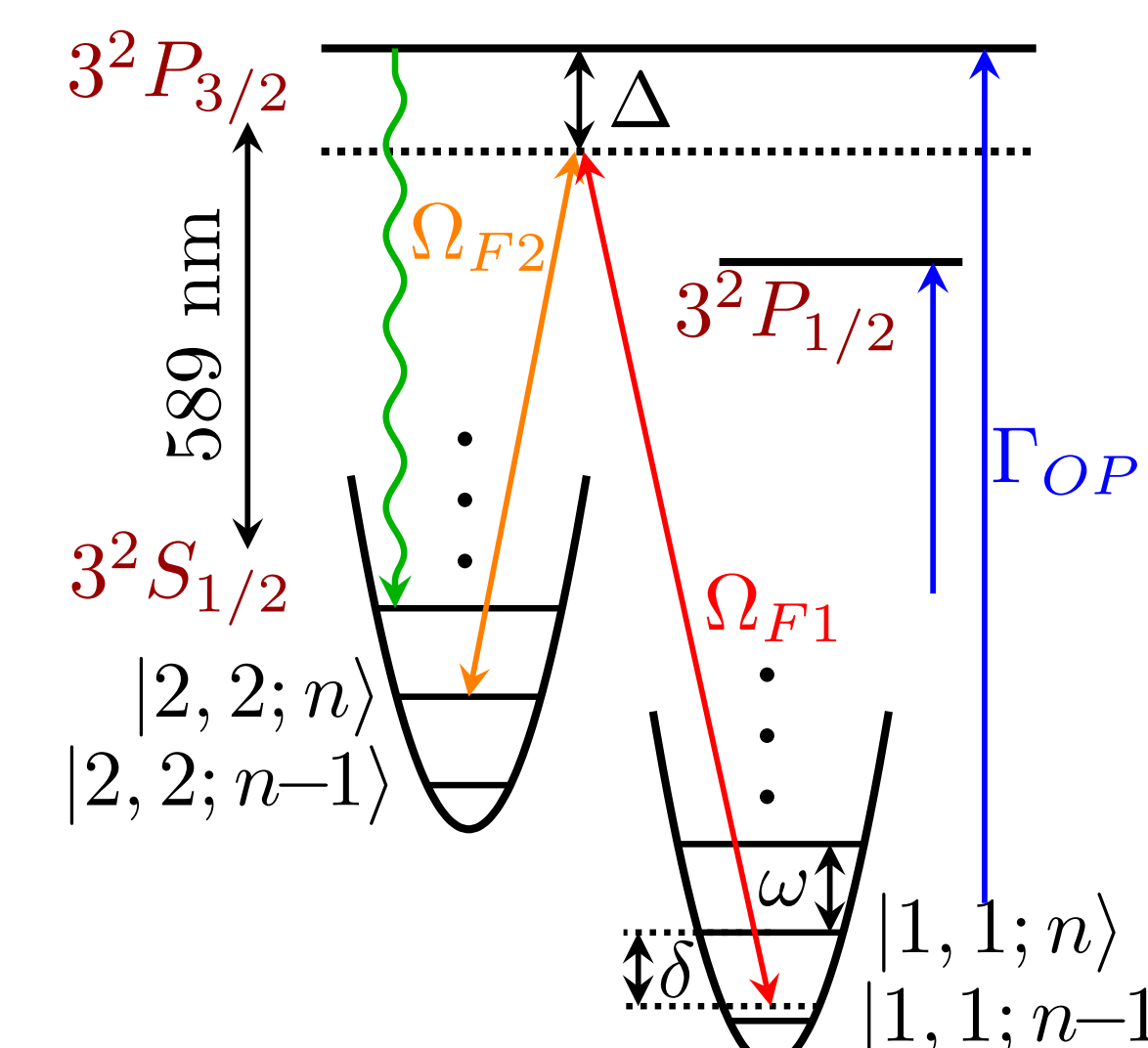
Laser-cooled and trapped single Cs and Na atoms < 100 uK in separate rearrangeable optical tweezers.



Hutzler, Liu, Yu, Ni, *New J. Phys* 19, 023007 (2017)

L. Liu, Zhang, Yu, Hutzler, Hood, Liu, Rosenband, Ni, *arXiv:1701.03121* (2017)

Cooled into motional ground states in the tweezers with Raman sideband cooling. Cooling fidelities are 96% for Cesium and 94% for Sodium.



Yu, Hutzler, Zhang, L. Liu, Rosenband, Ni, *arXiv:1708.03296* (2017)

## Merging Tweezers

## Photoassociation

### Coherent molecule formation (Preliminary)