

Ultracold molecule assembly

Yichao Yu

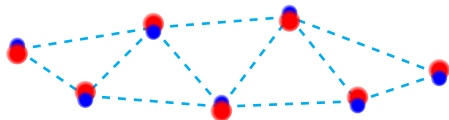
Ni Group/Harvard

Aug 11, 2017

Molecules in optical tweezer

Features

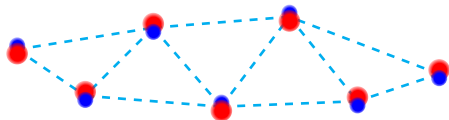
- Strong and tunable interaction
- Rich internal energy levels
- High filling fraction
- Single site detection and manipulation



Molecules in optical tweezer

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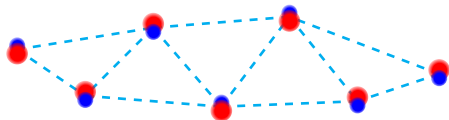
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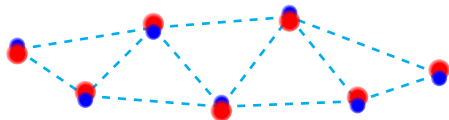
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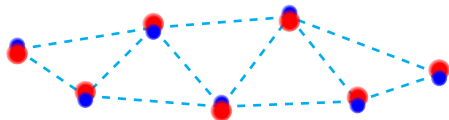
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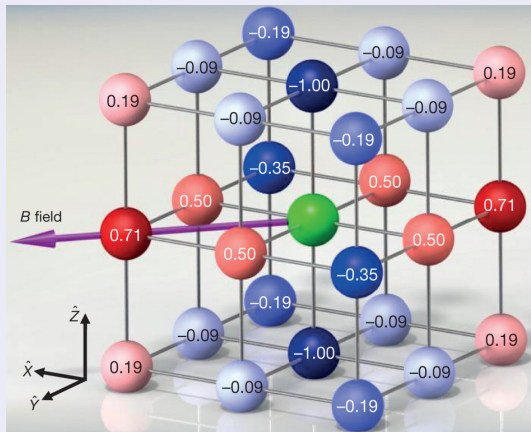
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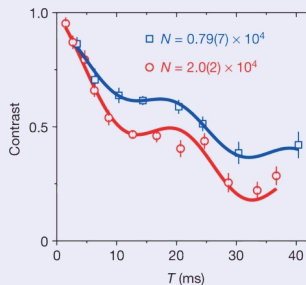
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Simulation of many-body system^[1]

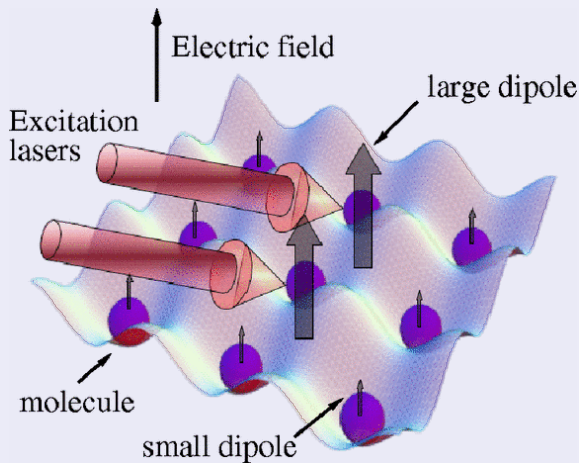


$$H \propto \sum_{ij} V_{ij} (S_i^+ S_j^- + S_i^- S_j^+)$$



[1] B. Yan et al., “Observation of dipolar spin-exchange interactions with lattice-confined polar molecules.”, *Nature* **501**, 521–5 (2013).

Quantum computation^[2]



[2] S. F. Yelin et al., “Schemes for robust quantum computation with polar molecules”, 4 (2006).

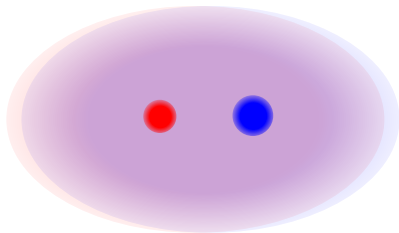
Making molecules from atoms

- MOT (Na + Cs)
- Loading single atoms
- Raman sideband cooling
- Merge traps
- Make molecules!



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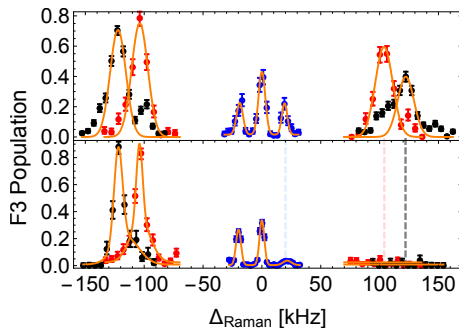
Atom loading and cooling

- Single atoms
- 85% ground state after Cesium Raman sideband cooling

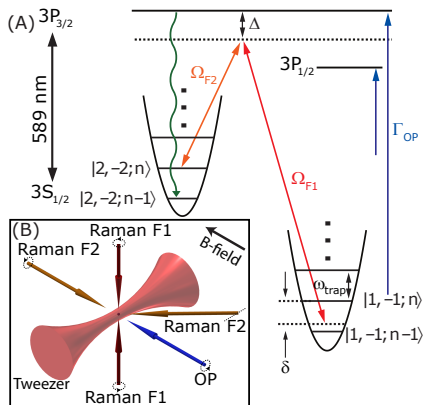


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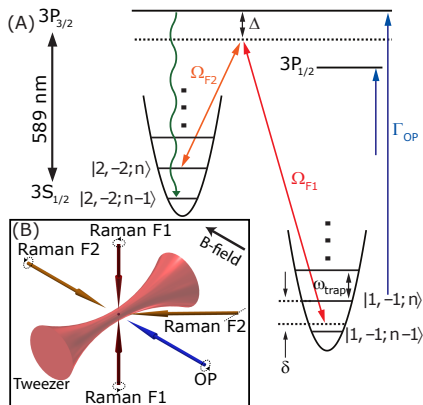


Raman sideband cooling



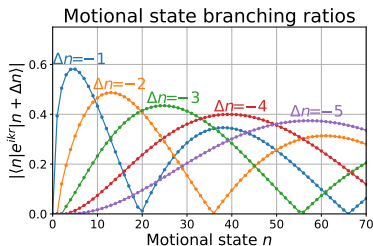
- High initial temperature ($70\mu K$)
- High Lamb Dicke parameter
- Large light shift (scalar and tensor)
- Trap anharmonicity

Raman sideband cooling



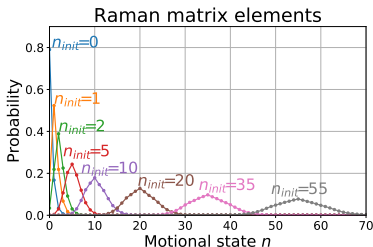
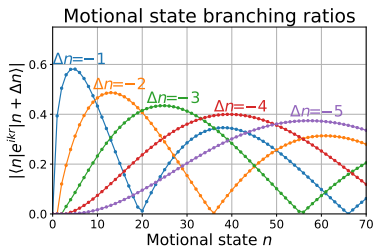
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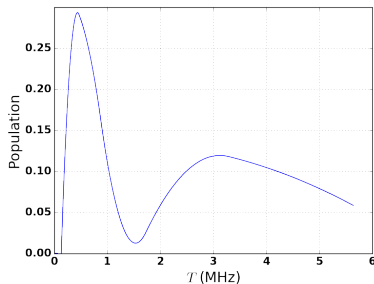
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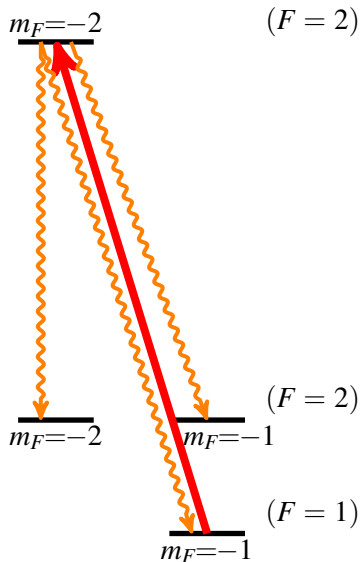
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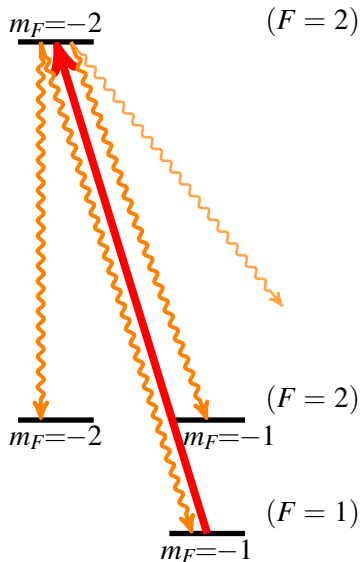
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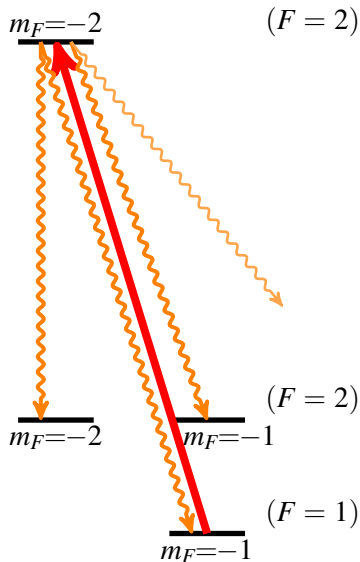
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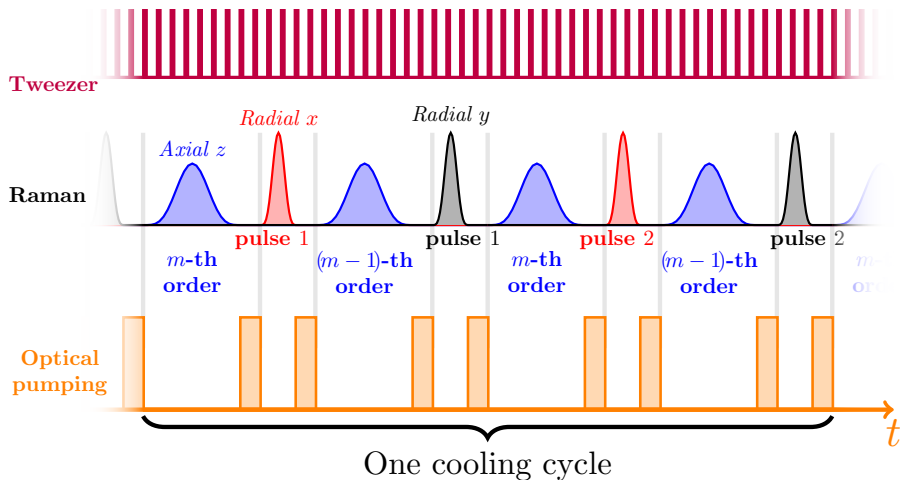
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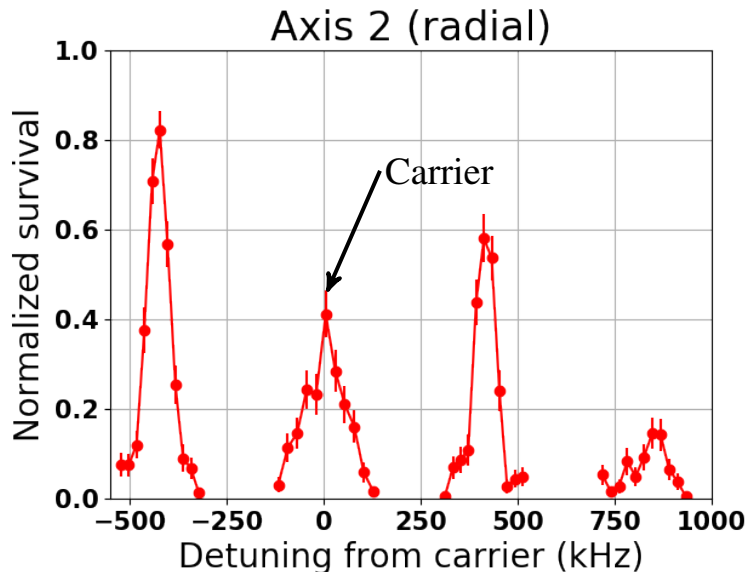
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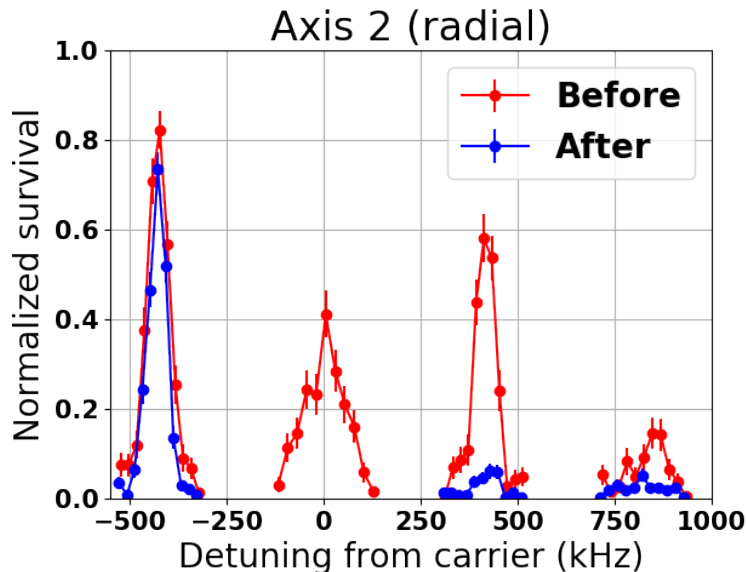


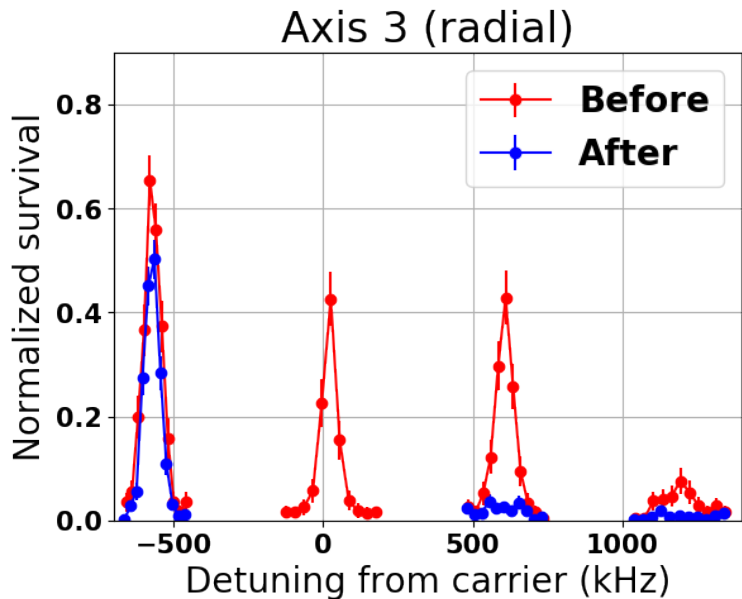
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Sequence

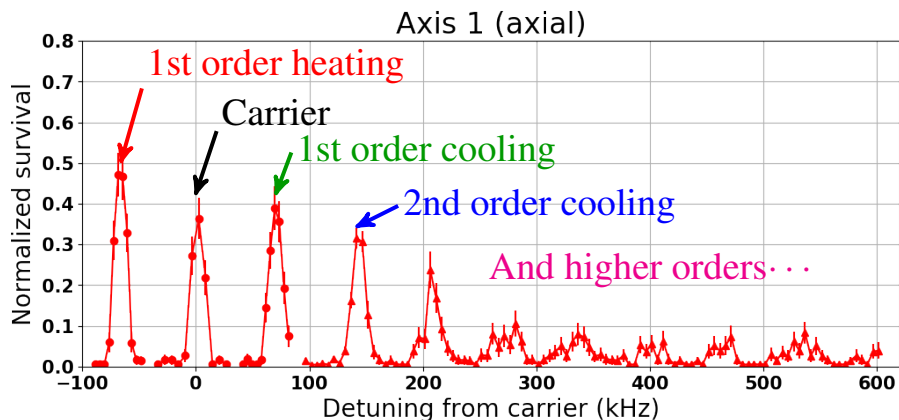




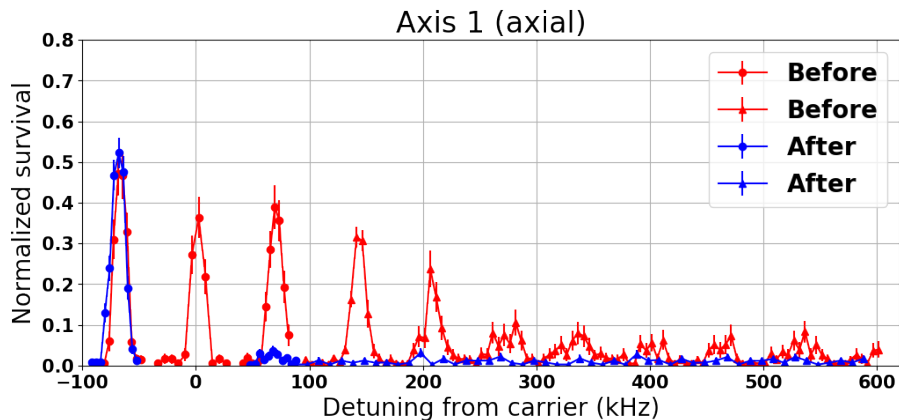




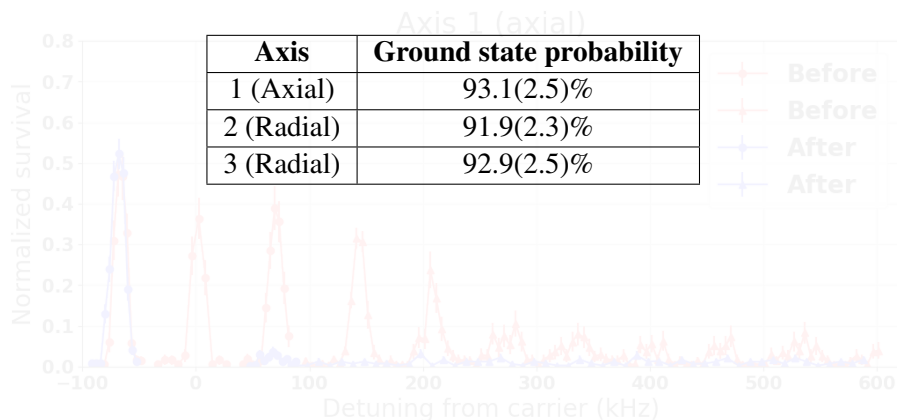
Raman sidebands



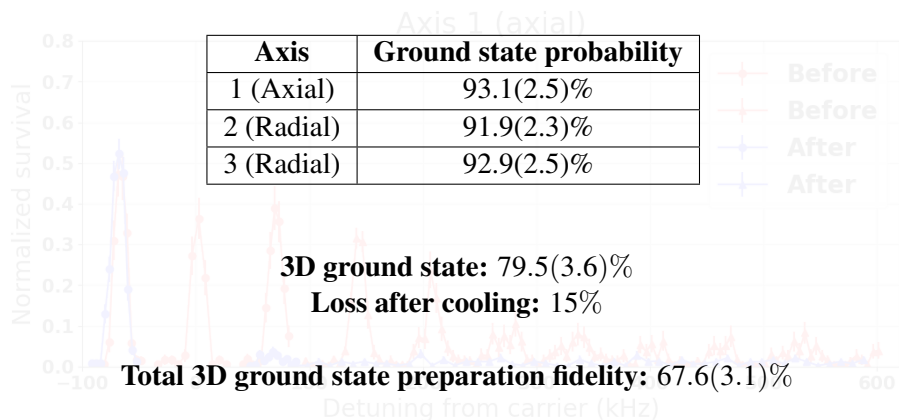
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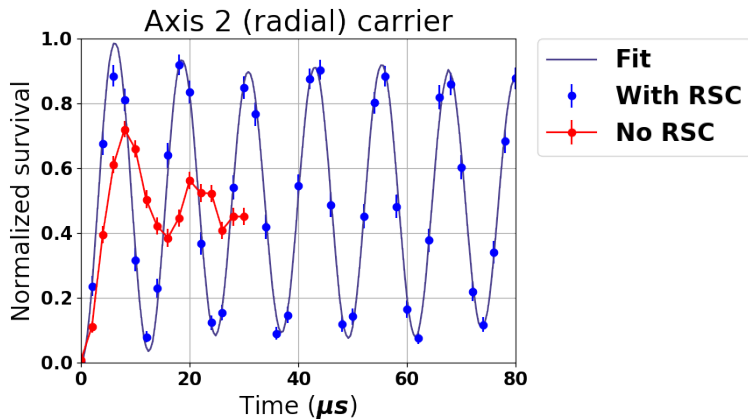
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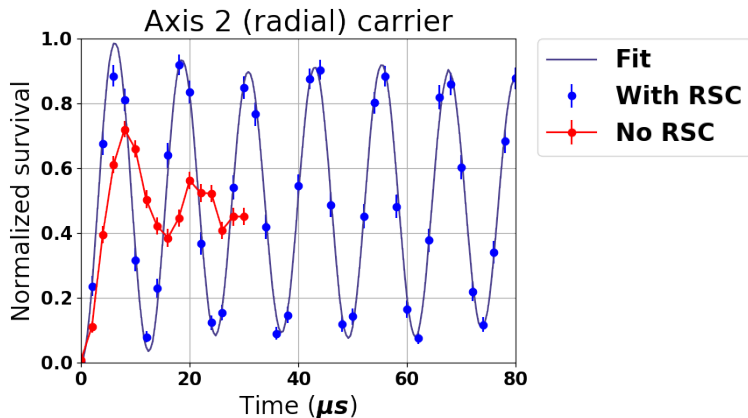
Raman sidebands



Rabi flopping (radial)

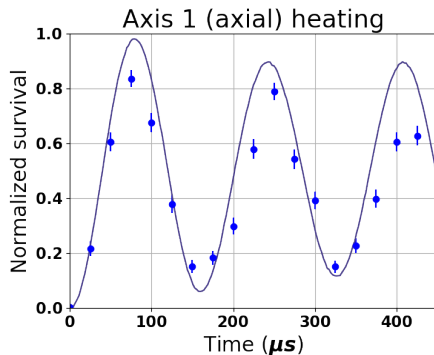
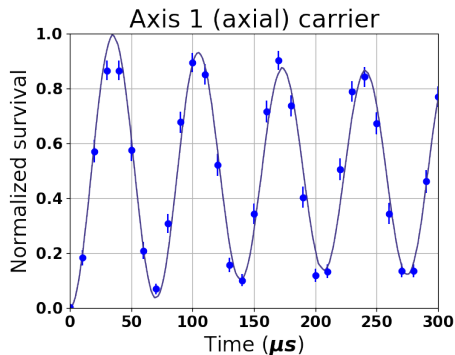


Rabi flopping (radial)



Good agreement in ground state probability between spectrum and Rabi flopping data.

Rabi flopping (axial)



Next step

