Production and Characterization of a Dual-Species Cold Atomic Beam

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Motivation

- Loading a dual-species trap from a cold, bright source will allow long trap lifetimes and quick-loading UHV MOTs, allowing more in-depth study of cold collisions involved in
    - 2-species sympathetic cooling
    - Binary mixtures of Bose condensates
    - Photoassociative spectroscopy

- Dual-species source suggested for the QuITE project, a proposed fundamental physics experiment aboard the International Space Station
    - Precision test of Einstein's Equivalence Principle using laser-cooled atoms
    - Proposed dual-species atom interferometer
    - GR tested to 10^3 times better accuracy than on Earth

- Further develop beam-operation and beam-simulation techniques for future laser-cooling work

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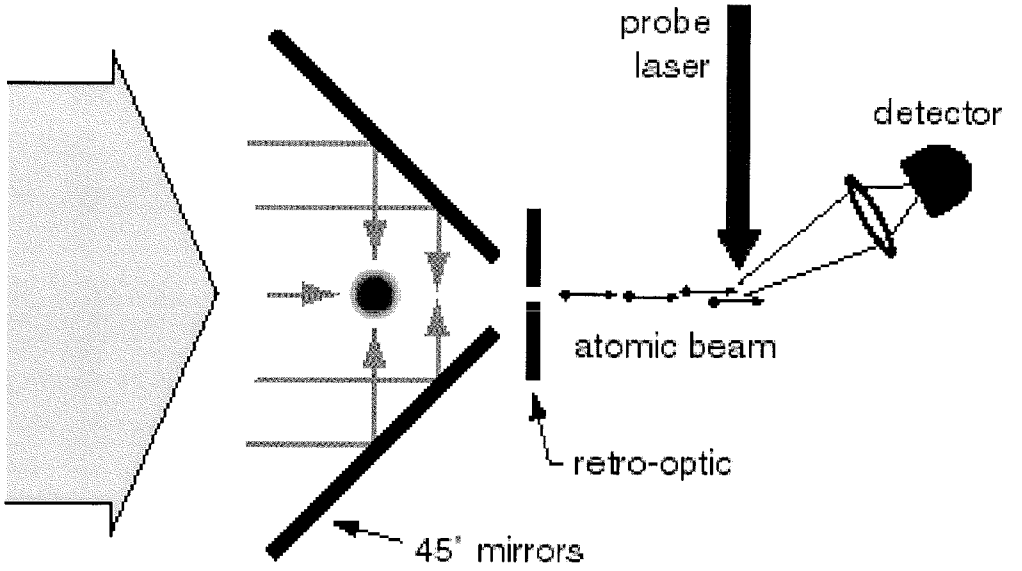
Experimental Design

- Pyramidal Low-Velocity Intense Source (LVIS)
- Large (D~15cm) trapping beams
  - Rubidium: > 500 mW Ti:Sapphire
  - Cesium: > 300 mW MOPA
- 1-mm hole in retrooptic generates beam
- Lock-in detection of atomic beam



- Twin beams load UHV MOTs
  - Beam flux ~2 x 10^9 atom/s, each species
  - Downstream MOT at ~10^{-11} Torr
  - Full independent control of loading/decay

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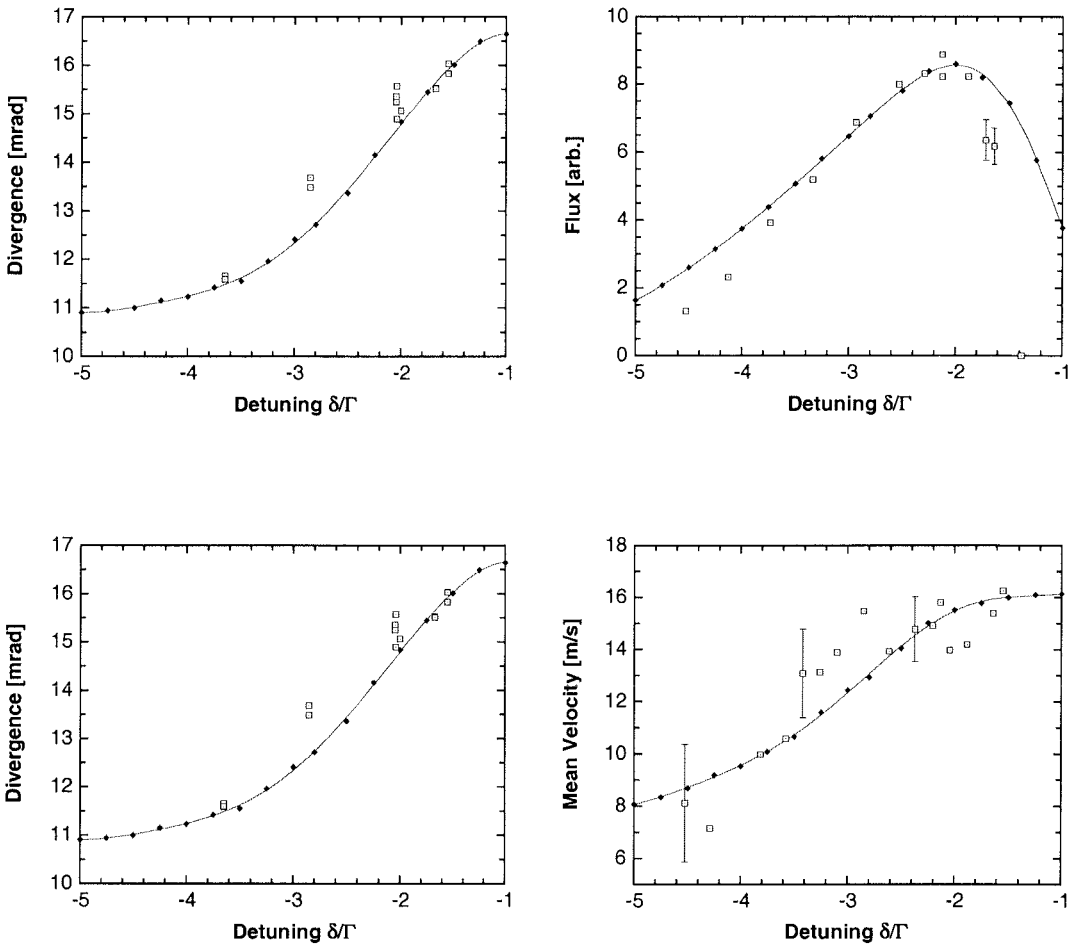
Beam Simulation I

(Theoretical model vs. Experiment)



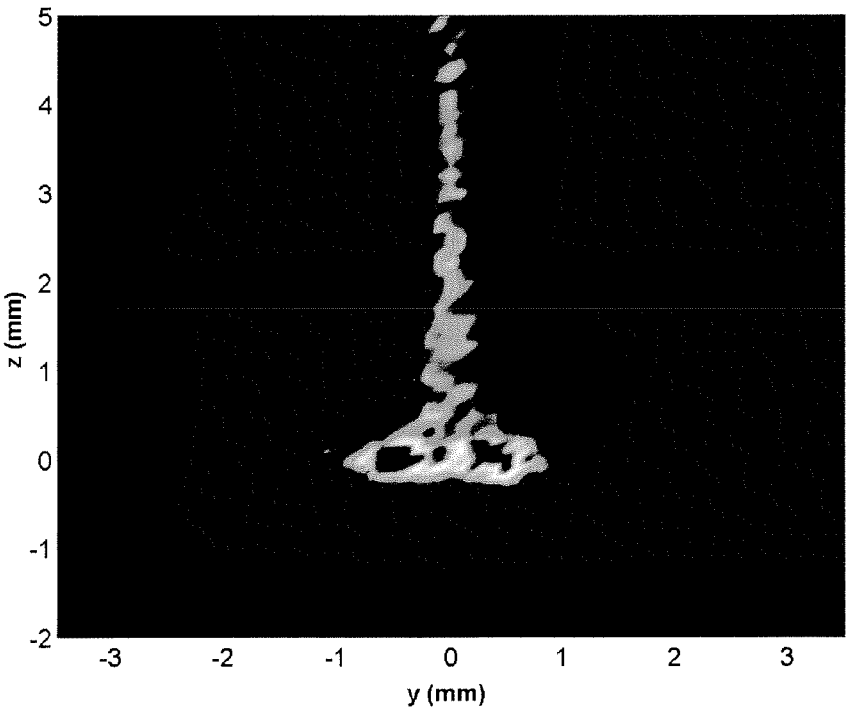
- Theoretical model incorporates recoil heating, collisional losses, and multiple-scattering forces.

- Model gives correct sizes and density for standard MOT, and returns correct Doppler temp.

Beam Simulation II

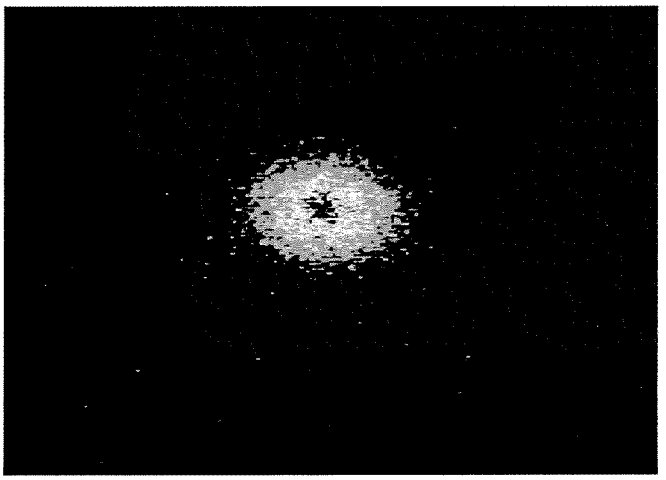
Cs LVIS in action: MOT + 4 reflections

Simulated beam

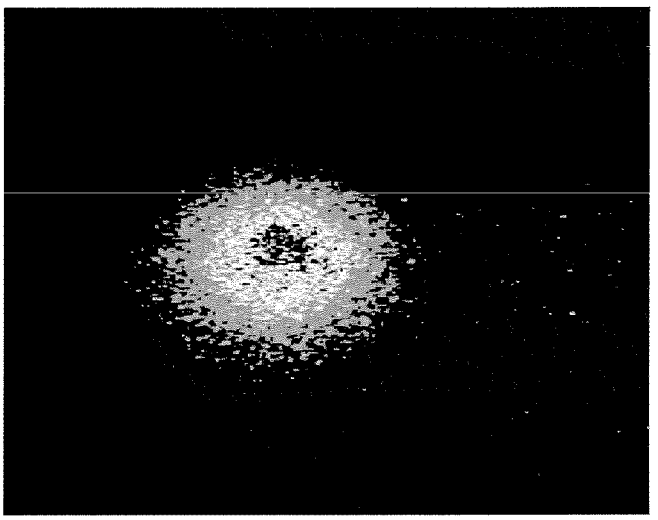


Dual-species UHV MOTs

Rb: N~10^8

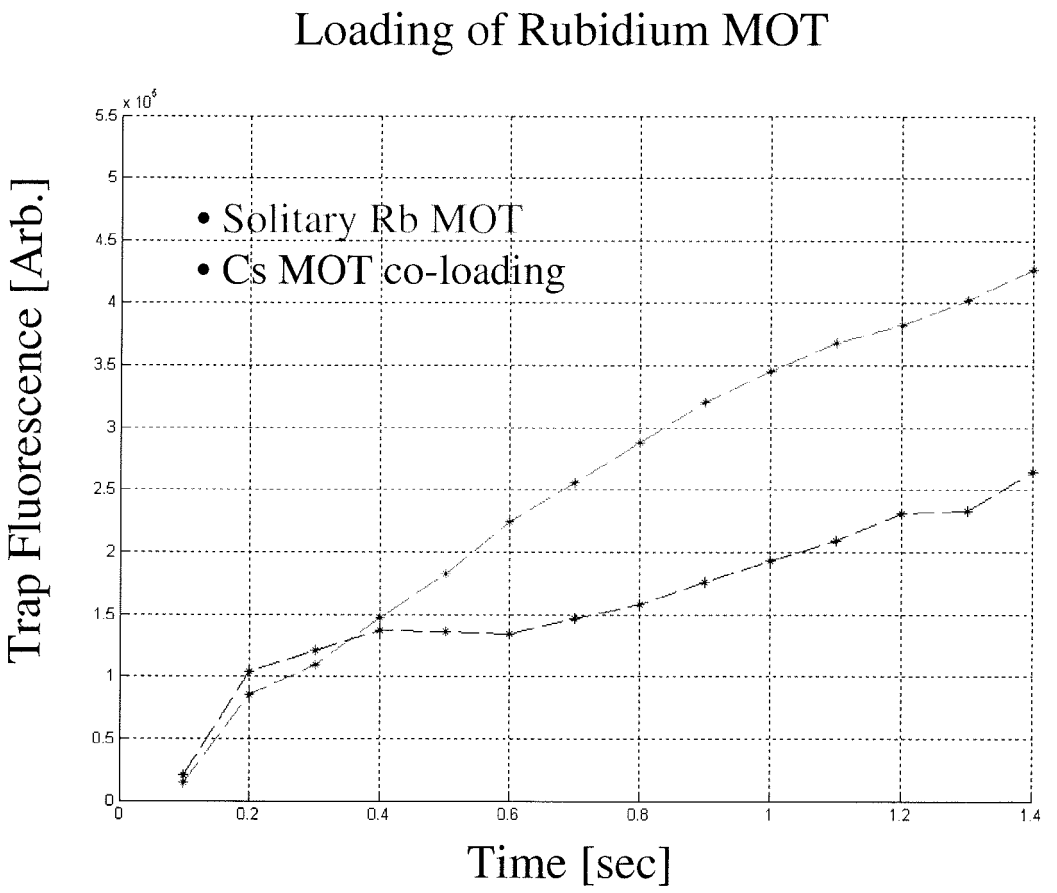


Cs: N>10^8



- (All pictures taken with 780nm or 850nm bandpass filters)
- Loading times observed as low as < 2 sec.
- Lifetimes observed as long as ~10 sec.

Collisional effects in dual-species MOTs



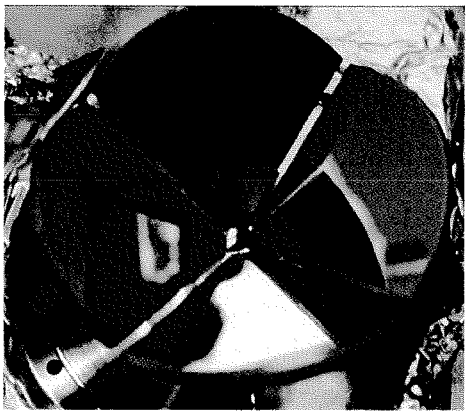
- Presence of co-loading Cs MOT affects Rb loading rate, as seen in vapor cell MOT (Telles, PRA **63** 033406): loss rate due to Cs-Rb cold collisions.

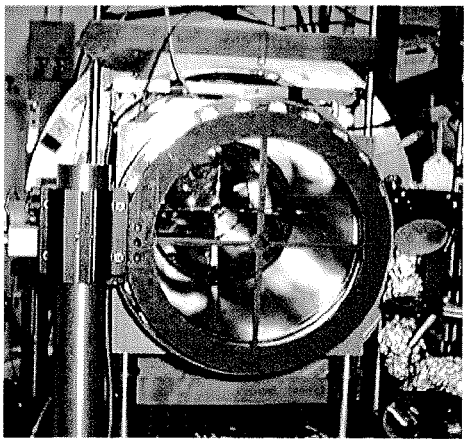
- Rates appear equal early on: minimal beam effect

Future work

- Extensive characterization of collisional effects in dual-species MOT
  - Dependence of interspecies losses on intensity
  - Reciprocity studies of Cs traps with Rb background
  - Examination of steady-state trap behavior
- Use of high atomic flux for (near-unity capture efficiency) loading of magnetic traps
- Loading of dual-species optical traps
- Dual-species precision-measurement work (QuITE)

PREPRINTS AVAILABLE UPON REQUEST





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