Malleable Optical Trap Formed in a Bow Tie Cavity

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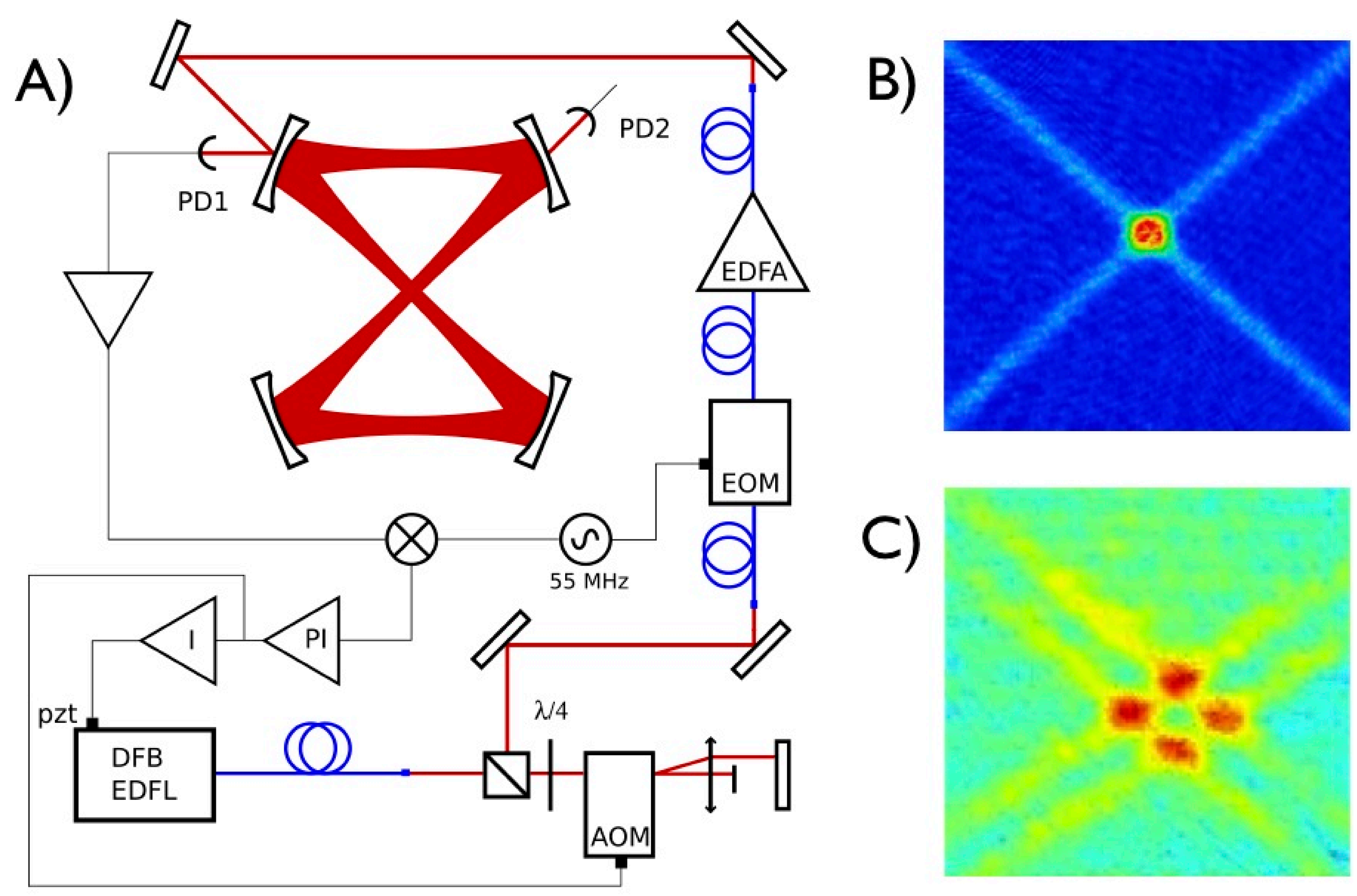
Objective

We propose a unique setup consisting of multiple transversally pumped BECs inside a sub-recoil, traveling wave (degenerate) cavity to explore the creation of novel quantum states including 'emergent' phenomena with ultra-cold atoms inside dynamical (compliant) optical lattices, photon-mediated long-range interactions inside a BEC, and the realization of entanglement between independent BECs.

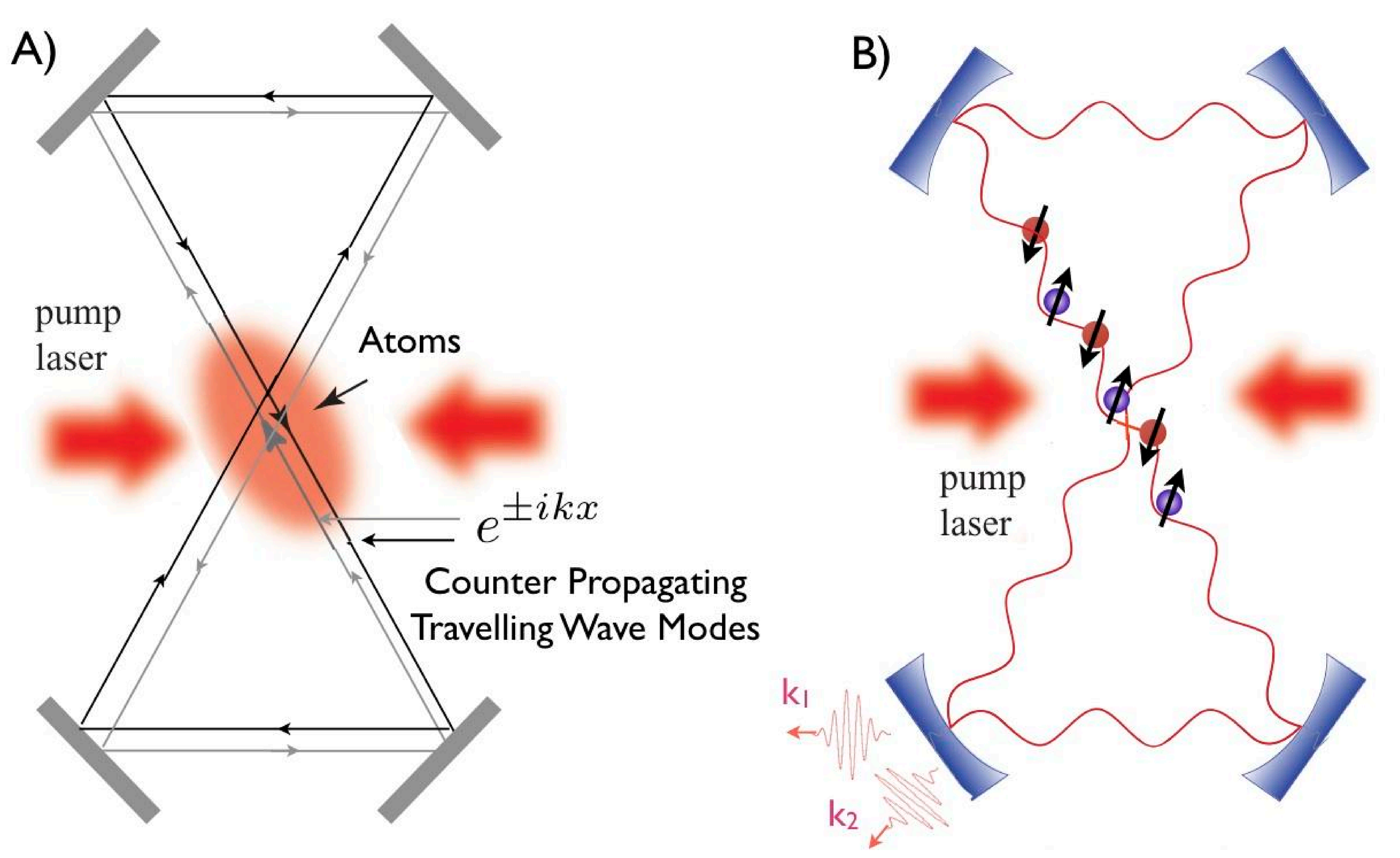
Experimental Setup

- **A)** a doubly degenerate **Bow Tie Cavity** with 1560 nm and 780 nm is loaded with ^{87}Rb atoms. The cavity can be pumped by 1560 nm light in the $TEM_{0,0}$ or the $TEM_{1,0}$ spatial mode of the cavity, creating either,
- **B) a single crossing point** or **C) four crossing points.**



Uniqueness of Our Scheme

- The standard **Fabry Perot Cavity** forces boundary conditions on the cavity light ⇒ **standing wave (static) intra-cavity lattice**.
- On the other hand our **Bow Tie Cavity (A)** supports traveling waves solutions ⇒ **dynamic intra-cavity lattice potential (B)**.



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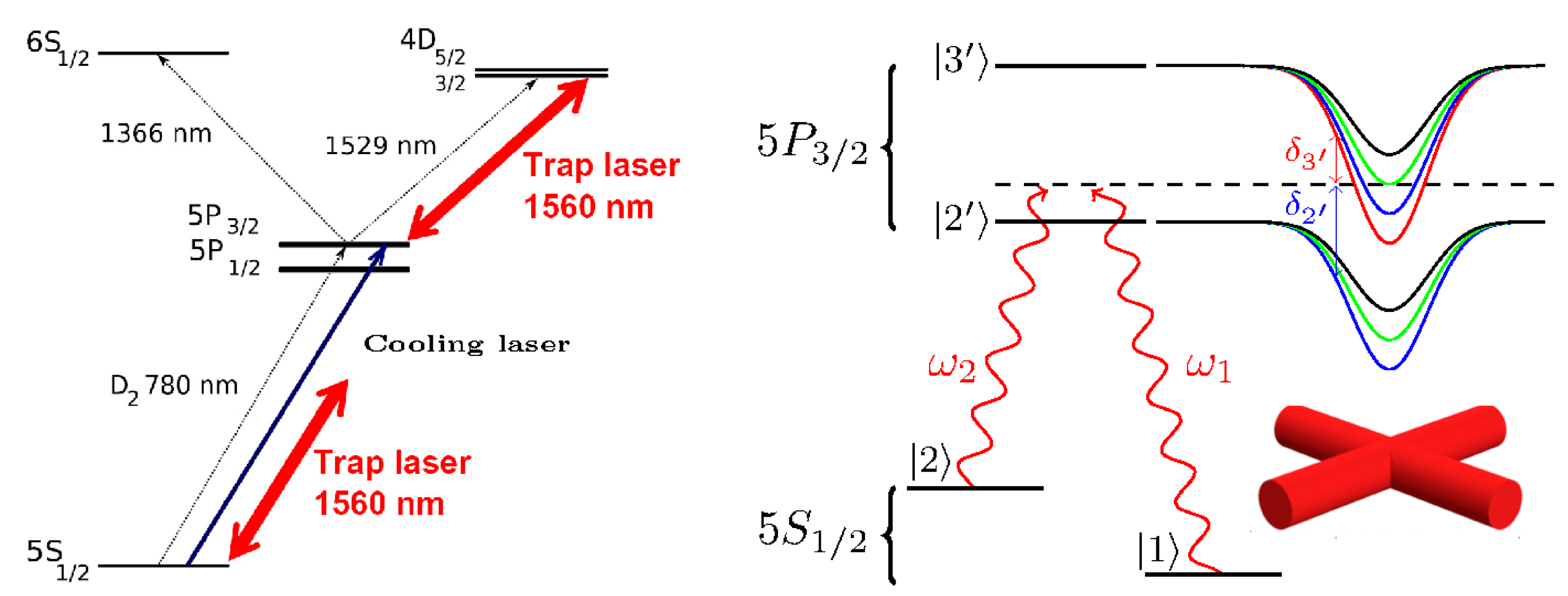
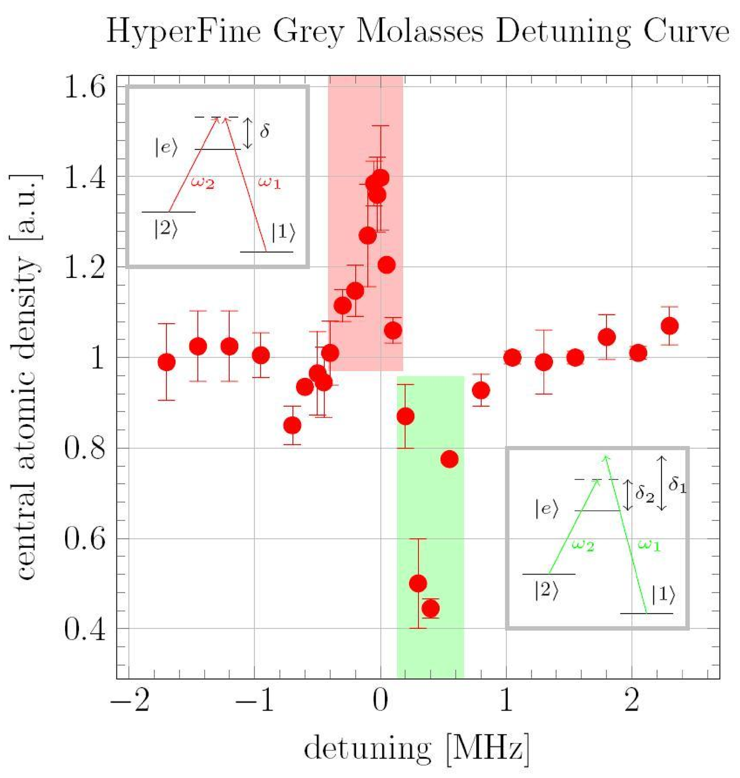
Differential AC Stark Shift

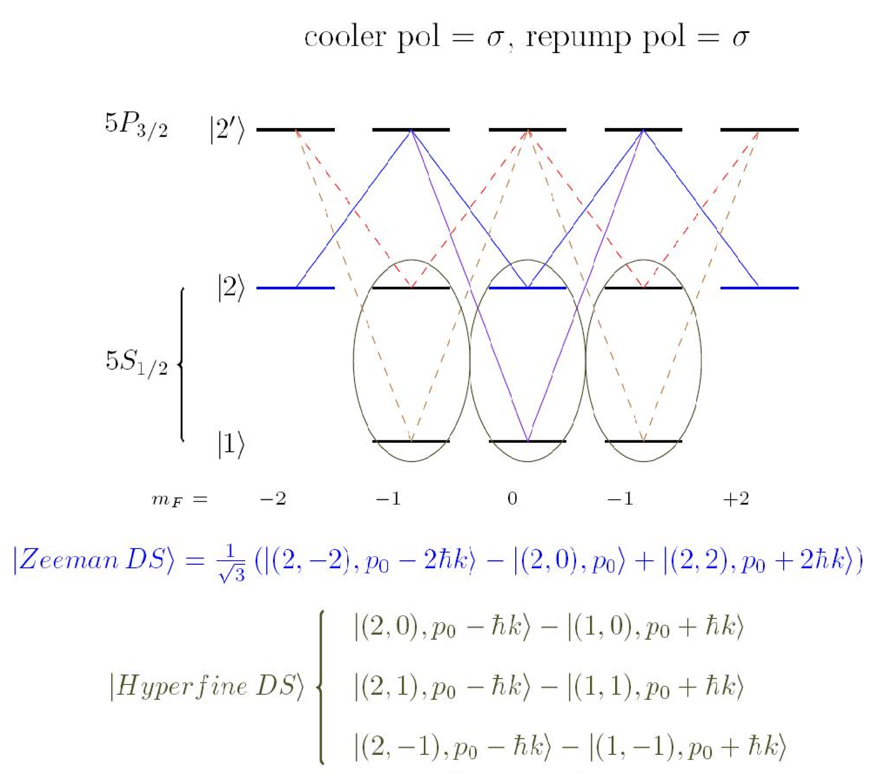
The far detuned 1560 nm dipole trap produces a large differential Stark shift between $5S_{1/2}$ and $5P_{3/2}$ manifolds of ^{87}Rb. Therefore, cooler and repump frequencies (ω_2 and ω_1 respectively) need to be adjusted inside the trap.

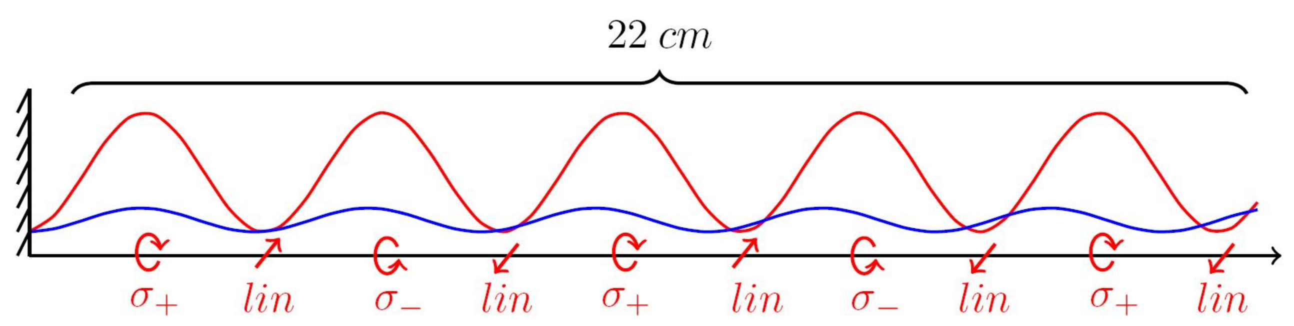


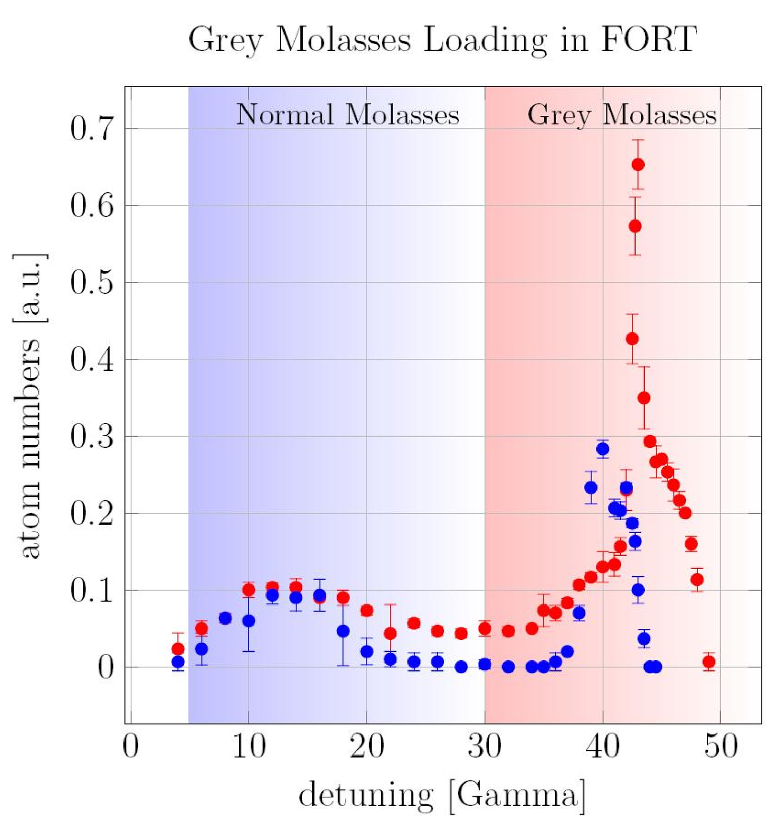
Results: Enhanced Loading and Cooling

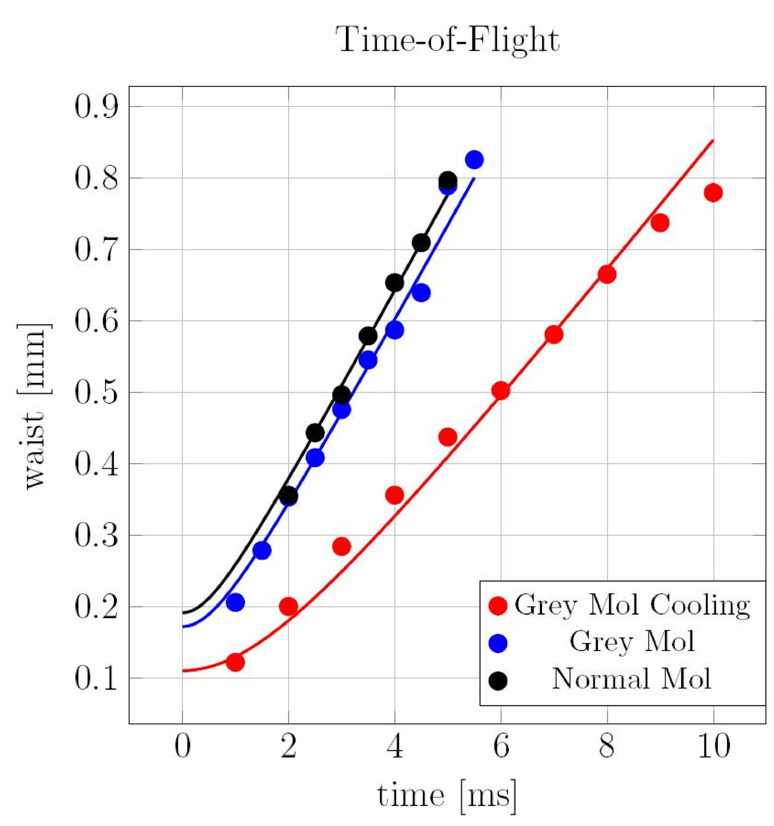
We present a new scheme to load and cool atoms into a dipole trap utilizing Hyperfine Dark and Bright states arising through two-photon Raman transitions. The combination of dark and bright states creates a Sysiphus like mechanism leading to 7 times more efficient loading of the dipole trap and 4 times lower temperatures.











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