Construction of an Ytterbium Laser Cooling and Trapping Apparatus

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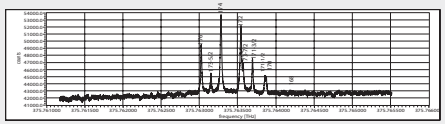
70 $^1S_0$
Yb
Ytterbium
173.04
$[Xe]4f^{14}6s^2$

Example of atoms that have been laser cooled and trapped:
- Alkaline atoms: H, Li, Na, K, Rb, Cs
- Alkaline earth atoms: Be, Mg, Ca, Sr, Ba, Ra
- Isoelctronic atoms: Zn, Cd, Hg, Yb

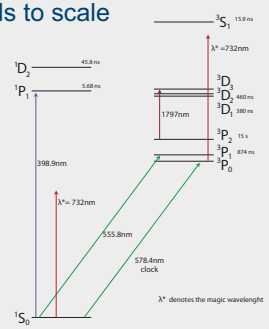
Yb isotopes:



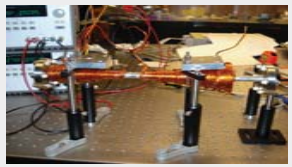
Advantages of using Ytterbium for laser cooling ang trapping

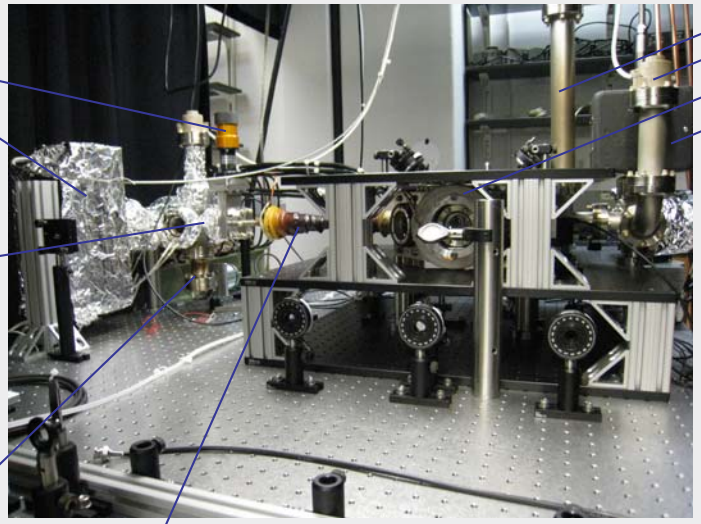
- Two readily available transitions which can be used for laser cooling and trapping 1S0->1P1 (399nm), and 1S0->3P1 (556nm)
- Ground state forms a close to perfect two level system due to the absence of a magnetic moment. Hence, it is insensitive to first order Zeeman shifts
- No need for repumper laser due to absence of ground state hyperfine structure in even isotopes
- Spin 0 isotopes are most abundant and can be easily trapped

Relevant Yb energy levels to scale

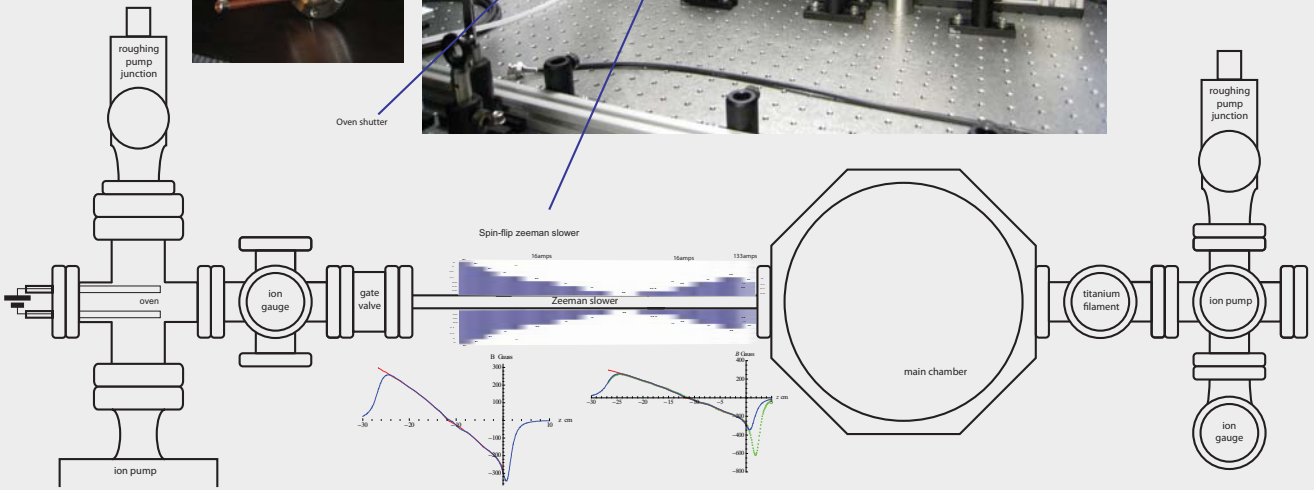


Yb laser cooling aparatus


Measuring the magnetic field of the spin flip slower

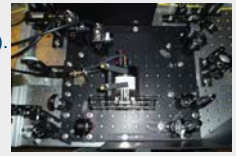


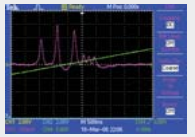

Yb flourescence in chamberr

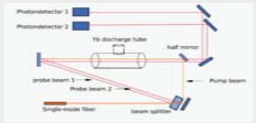


Laser locking setup

Saturation absorption spectroscopy (SAS) signal for locking laser to Yb transition (purple). Yb is vaporized in a commercially available cathode discharge tube. The pump beam is overlapped with probe beam 1. Probe beam 1 and probe beam 2 are detected from which we get an SAS signal







What are we doing now?

- Making a Yb Magneto-Optical trap on the 1S0->1P1 transition
- Building electronics to control laser cooling and trapping aparatus

Future direction of research

- Make a Bose Einstein Condensate
- Do atom interferometry using Laguerre-Gaussian beams
- Probe gravity at the micron scale by bringing ultracold atoms close to a surface
- Study atom-atom interaction in the context of ultracold collisions in quantum degenerate gasses