Construction of a Yb Laser Cooling and Trapping Apparatus

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Goal of this project

The long term goal of this project is to use an ultracold gas of Ytterbium (Yb) atoms for precision measurement of very weak forces (such as gravity on the micron scale) as well as studying atom-atom interactions in the context of ultra-cold collisions. On this poster, we describe the first steps towards making an ultracold Yb atom gas.

Advantages of Ytterbium for trapping

- Two laser transitions which are readily available for trapping and cooling: ¹S₀→¹P₁ (399nm), and ¹S₀→³P₁ (556nm)
- Absence of hyperfine structure in ground state so there is no need for repumper laser
- Have 7 stable isotopes, and cooling transition is close to a pure two-state system

Advantages of ultracold Yb for precision measurement of very weak potentials

- Can choose magic wavelength such that the AC stark shifts of ¹S₀ and ³P₀ are identical
- Narrow line laser cooling to T≈10 μK
- ¹S₀ and ³P₀ states have different static polarizabilities, which mean they will experience different Casimir-Polder shifts.
- Ratio of Casimir-Polder shifts is given by ratio of their polarizabilities.
- ¹S₀ and ³P₀ have zero magnetic moment (J=0), therefore only electric forces need to be considered here

Relevant energy levels of Ytterbium

Laser locking setup: