Physics 4062/5062 – Tutorial Four – Calibrating the Atom Trap

Finding Atom Number N

Calibrate Photodetector (PMT, Photodiode)

Determine detector responsivity in units of $\frac{Amps}{Watt}$

Recorded signal S (in Volts) is proportional to the responsivity

Fluorescence from Ne trapped atoms in excited state α $\frac{Energy(E)}{time(\tau)}$ from trapped atomic cloud

Ne=Nf where, N=Ng+Ne

Here Ng and Ne represent the number of atoms in the ground state and excited state respectively and $f = \frac{N_e}{N_g + N_e}$ is the fraction of atoms in the excited state.

$f = \frac{\frac{I}{I_{sat}}}{\left[1+\left(\frac{2I}{I_{sat}}\right)+\left(\frac{2\Delta}{\Gamma}\right)^2\right]}$ is determined by the total laser intensity I incident on the atom cloud, the laser detuning Δ and the saturation intensity Isat

So Ne=Nf α $\frac{S}{\frac{E}{\tau}} = \frac{S}{E\Gamma}$

$$N \propto \frac{S}{fE\Gamma}$$

$$N_{correected} \propto \frac{S}{fE\Gamma}\frac{4\pi}{\Omega}$$

Here, Ω is the solid angle subtended by trap at the location of the detector. It is assumed that the fluorescence emitted by the cloud is isotropic.

Therefore, the atom number can be determined from the detector calibration and a careful measurement of the solid using the calibration of the detector and a careful measurement of the solid angle.

Atomic Density

The density can be inferred by measuring the trap volume using the CCD and by using the atom number. The trap size can be measured by calibrating the CCD.