Physics 4062/5062 – Tutorial Eight – Trap Loading Time and Optical Pumping

Trapping From Atomic Beam

Atom Trap

MOT

Atom Beam

Low Vacuum Chamber

High Vacuum Chamber
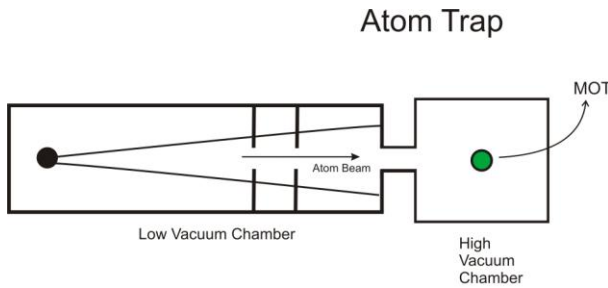
The source of atoms can be shut off by blocking the slit between vacuum chambers. The loss of trapped atoms is predominantly due to collisions with the background atoms. This results in an exponential decay of fluorescence modeled on the basis of the equation

$$\frac{dN}{dt} = -\Gamma_{coll}\, N$$

$\Gamma_{coll} = n\sigma v_{rel}$ is the collisional rate.

Vapor Cell MOTs - Trapping from Background Vapour

Vacuum Chamber

Atoms from Walls

Atom Trap
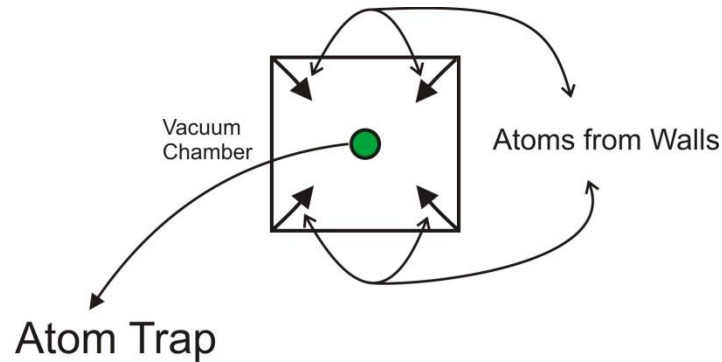
Source of atoms is within the chamber and cannot be turned off.

$$\frac{dN}{dt} = L - \frac{N}{t}$$

$$N \sim N_o \left[1 - e^{-\frac{t}{\tau_c}} \right]$$

Here, L is the loading rate given by the number of atoms per unit time entering the trap with $v < v_{capture}$. At equilibrium, $N_0 = \tau_c L$, where τ_c is the collision time and the collisional rate $\Gamma_{collision} = \frac{1}{\tau}$. n represents the density of hot background atoms colliding with trapped atoms, σ is the collision cross section and v_{rel} is the relative velocity between hot and cold atoms. By measuring τ_c and using the known value of σ, n and background pressure P can be determined.

1 - exp[-t/τ_c]