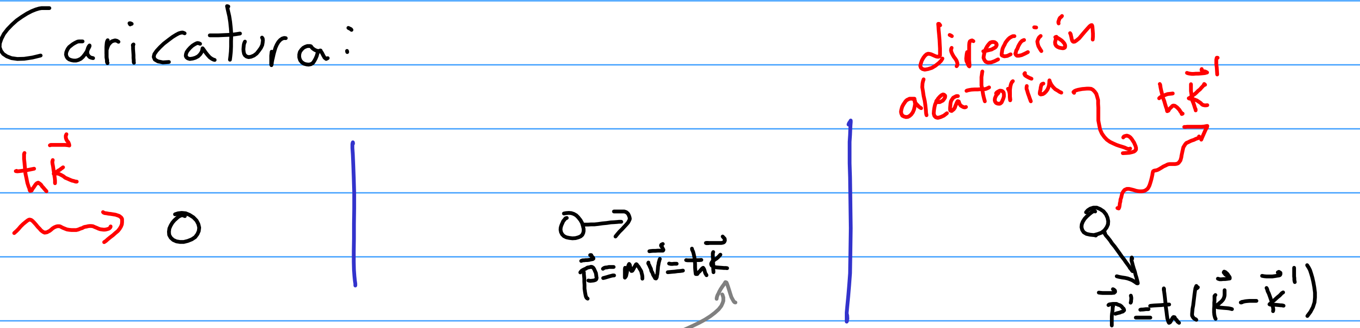
Fuerza radiativa y aplicaciones

$$\vec{F}_{rad}(\delta) = \hbar\vec{k}\,\frac{\Omega^2/\Gamma}{1+\frac{4\delta^2}{\Gamma^2}+\frac{2\Omega^2}{\Gamma^2}}$$

(para onda plana
átomo de 2 niveles
solución estacionaria
$kv \ll \Gamma, \Omega$)

Caricatura:



absorción de dirección $\hbar\vec{k}$

emisión con dirección aleatoria.

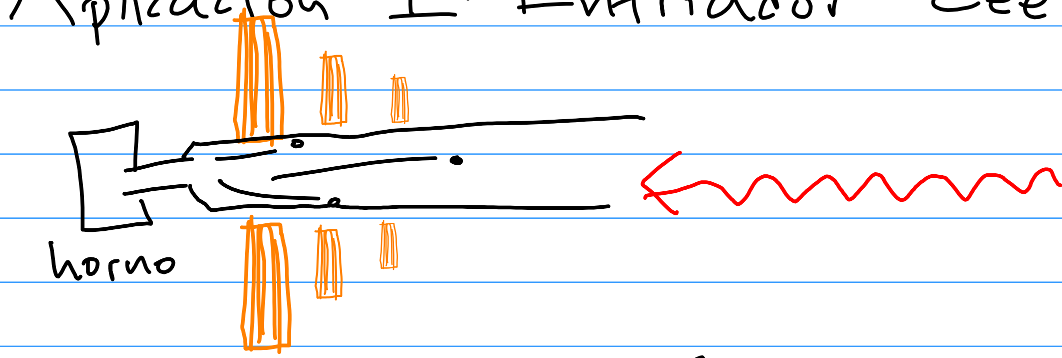
$\vec{F}_{rad}$ depende de la velocidad de los átomos por medio del efecto Doppler

$$\delta_{eff} = \delta - \vec{k}\cdot\vec{v}$$

en el M.R. del átomo. — en el M.R. de la fuente de luz. — luz — átomos

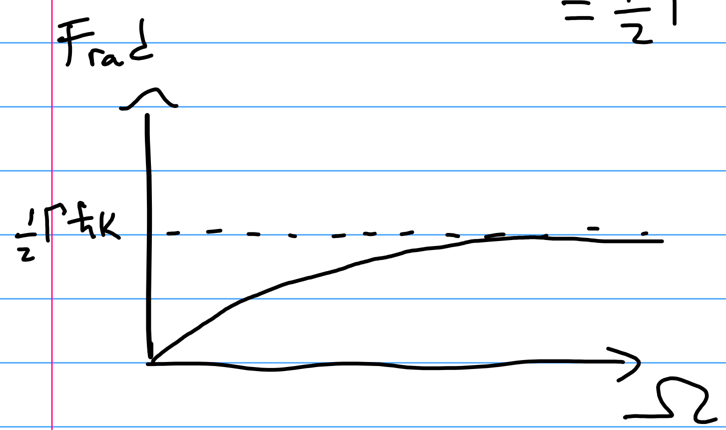
$$\vec{F}_{rad}(\delta - \vec{k}\vec{v}) = \vec{F}_{rad}(\delta) - \vec{k}\vec{v}\,\frac{\partial F_{rad}}{\partial\delta}(\delta)$$

Aplicación 1: Enfriador Zeeman



$$\vec{F}_{rad}(\delta) \xrightarrow[\Omega\to\infty]{} \hbar \vec{k}\, \frac{\Omega^2/\Gamma}{2\frac{\Omega^2}{\Gamma^2}}$$

$$= \frac{1}{2}\Gamma \hbar \vec{k}$$



$$m_{^{87}Rb} = 1.4 \times 10^{-25}\ Kg$$

$$\Gamma = 2\pi\, 6\ MHz$$

$$k = \frac{2\pi}{780\,nm}$$

$$\frac{F_{rad}^{\Omega\to\infty}}{mg} \sim 10^4$$

Para el enfriador Zeeman

de la transición

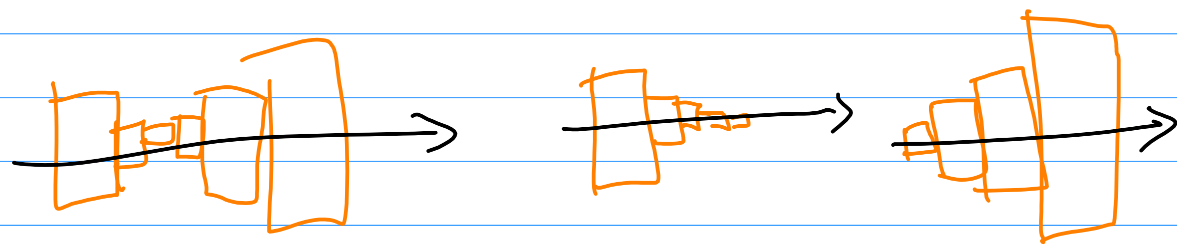
$$\delta_{eff} = \delta + k v(z) - \frac{g \mu_B B(z)}{\hbar}$$

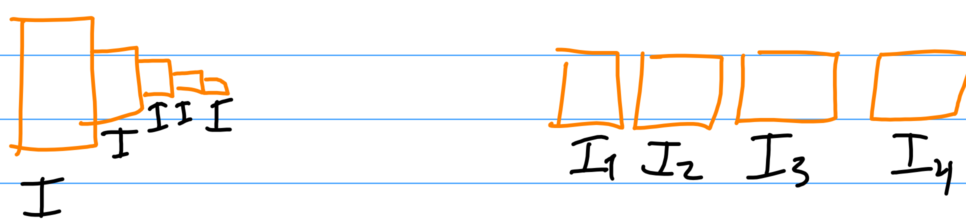
Queremos que $\delta_{eff} = 0 \Rightarrow B(z) = \frac{(\delta + k v(z))\hbar}{g \mu_B}$

Para una aceleración constante, ¿Cómo es $V(z)$?

$$V(z) = \sqrt{\overbrace{V_0}^{\text{vel inicial}}{}^2 - \overbrace{a_0}^{\text{aceleración}} z}$$

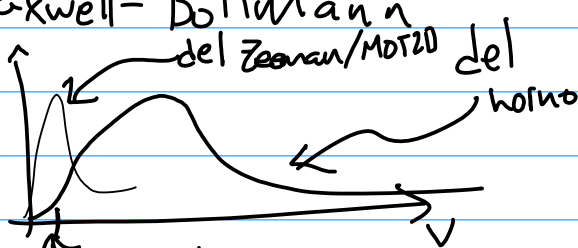
$$\therefore\ B(z) = \frac{\hbar}{g\mu_B}\left(\delta + k\sqrt{V_0^2 - a_0 z}\right)$$

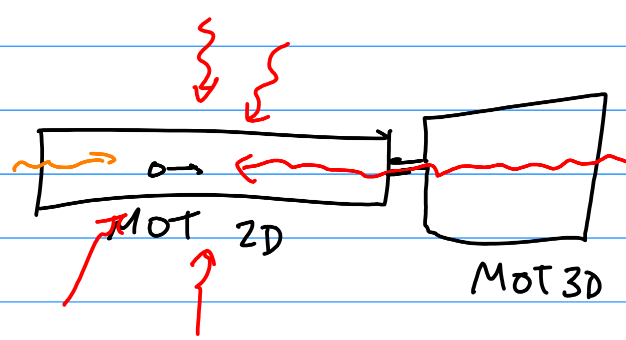




MOT 2D

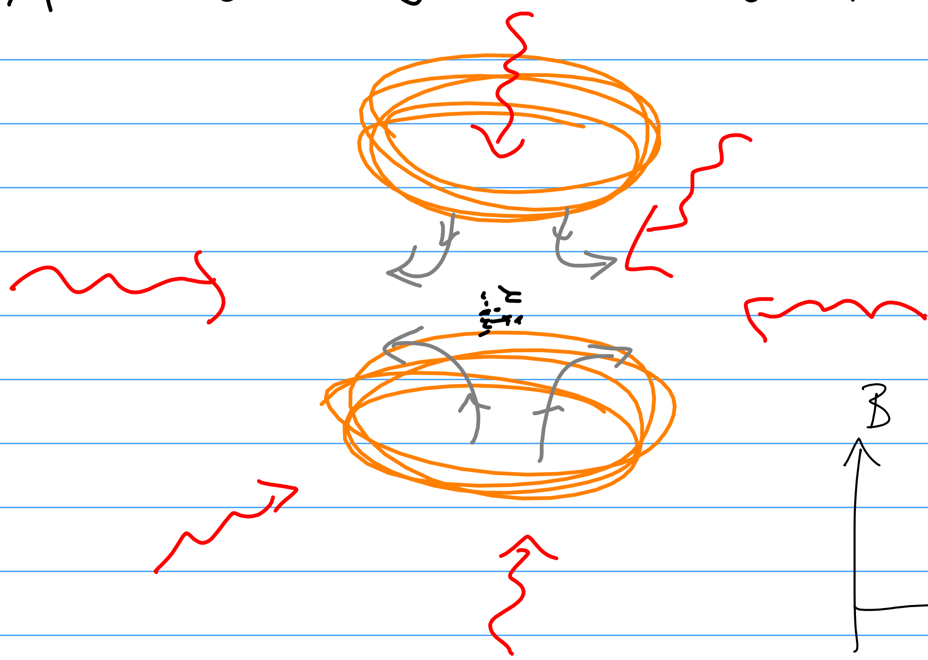
Maxwell- Boltzmann

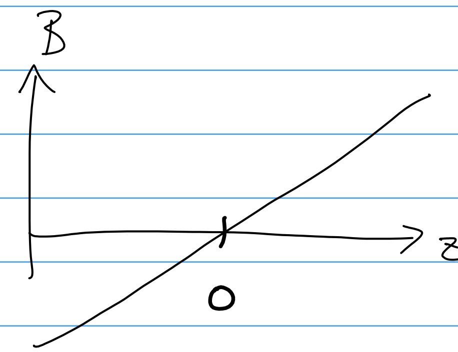


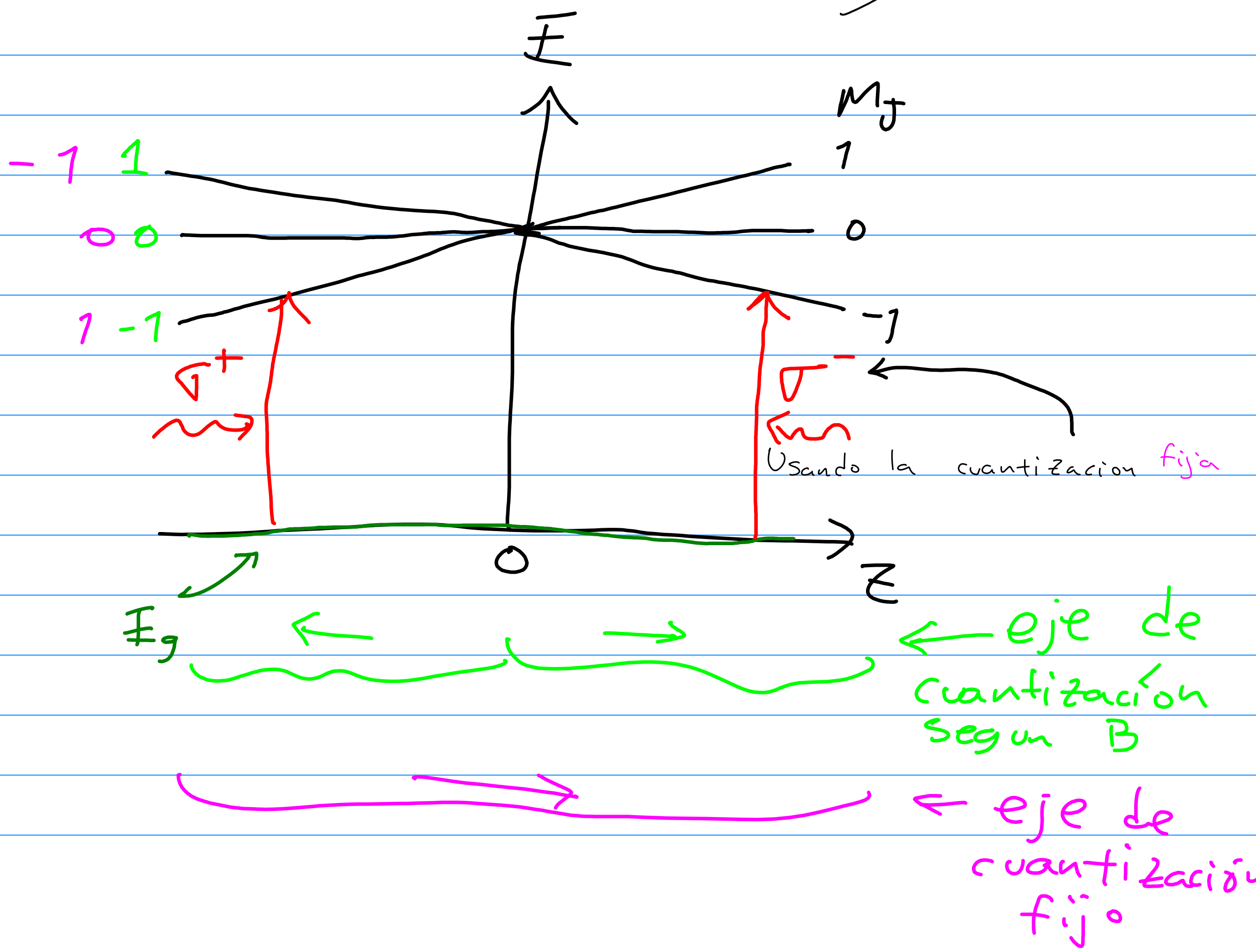


(MOT)

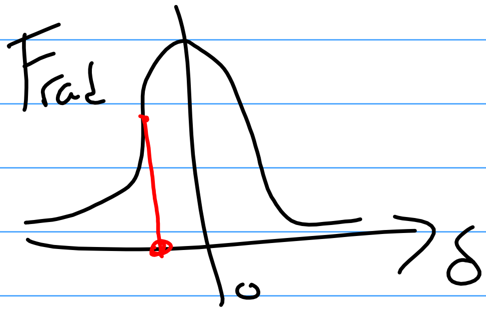
- Trampa magneto-óptica (TMO)
- Átomo $J=0 \rightarrow J=1$





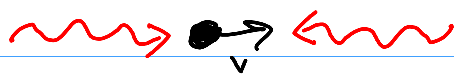


¿Cómo es que enfría?

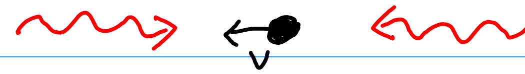


$$\vec{F}_{rad}(\delta) = \hbar \vec{k} \, \frac{\Omega^2/\Gamma}{1 + \frac{4\delta^2}{\Gamma^2} + \frac{2\Omega^2}{\Gamma^2}}$$

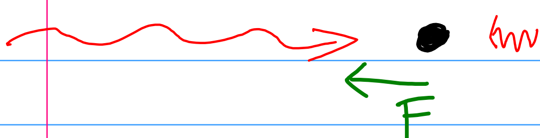
MR lab



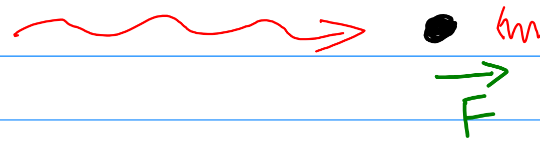
MR lab



MR átomo



MR átomo



$$\vec{F} \sim -\vec{v}$$