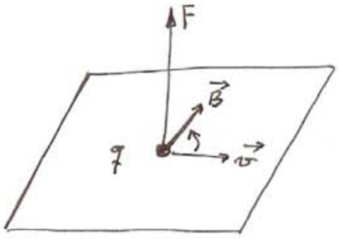
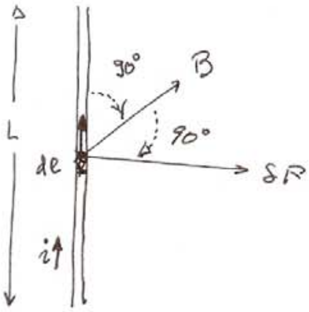
FORÇA MAGNÈTICA



$$\vec{F} = q\,(v \wedge B)$$

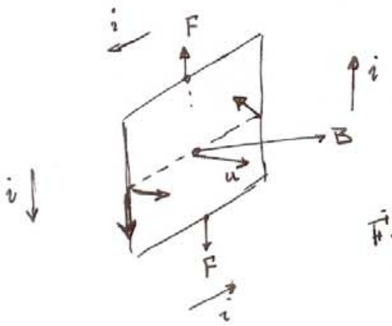
FORÇA SOBRE UN FIL CONDUCTOR

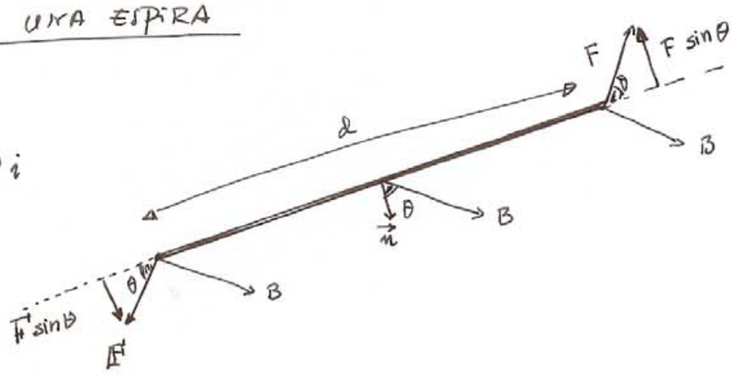


$$\left.\begin{array}{l} \delta F = \rho\, dl\,[v \wedge B] = \rho\, dl\, v\, B \\ i = \dfrac{dq}{dt} = \rho\,\dfrac{dl}{dt} = \rho v \end{array}\right\} \quad \delta F = i\,B\,dl$$

$$\Rightarrow \quad F = i\,L\,B$$

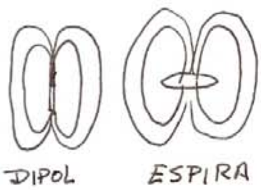
MOMENT SOBRE UNA ESPIRA



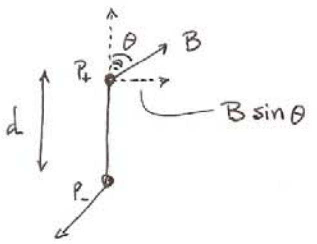


$$M = F \sin\theta\, d = (i\,B\,L)\, d \sin\theta = i\,S\,B \sin\theta$$

$$= i\,\vec{S} \wedge B = \vec{\mu} \wedge \vec{B}$$



RELACIÓ DIPOL - ESPIRA

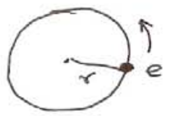


$$M = \underbrace{d \cdot p}_{\mu}\, B \sin\theta$$

$$M = \mu \wedge B$$

ESPIRA : $\vec{\mu} = i\,\vec{S}$

RELACIÓ DIPOL - MOMENT ANGULAR



$$L = r \wedge p = m v r$$

$$\mu = i S = \frac{dq}{dt} S = \rho \frac{dl}{dt} S = \rho v \pi r^2$$

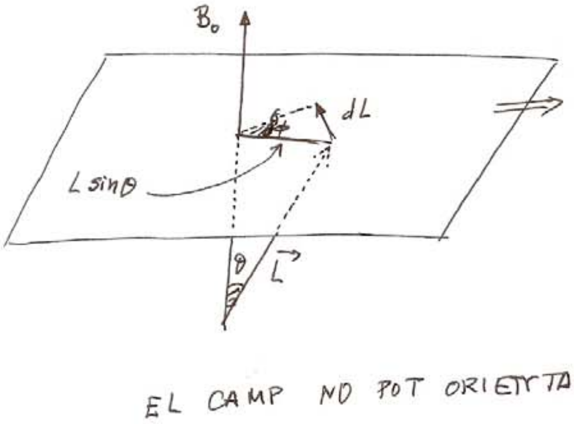
$$= 2\pi r \rho \frac{v}{2} r = \frac{e}{2} v r$$

$$\Rightarrow \boxed{\mu = \frac{e}{2m} L}$$

PRECESSIÓ DE LARMOR

$$\left.\begin{aligned} M &= \mu \wedge B \\ \mu &= \frac{e}{2m} L \\ M &= \frac{dL}{dt} \end{aligned}\right\} \quad \frac{dL}{dt} = \frac{e}{2m} L \wedge B$$

$$\boxed{dL \perp \{L, B\}}$$



$$\Rightarrow \frac{dL}{dt} = L \sin\theta \frac{d\phi}{dt} = L \sin\theta\, \omega$$

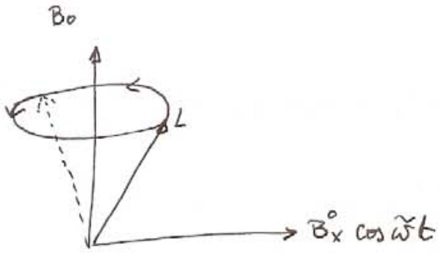
$$\parallel$$

$$\frac{e}{2m} L B \sin\theta$$

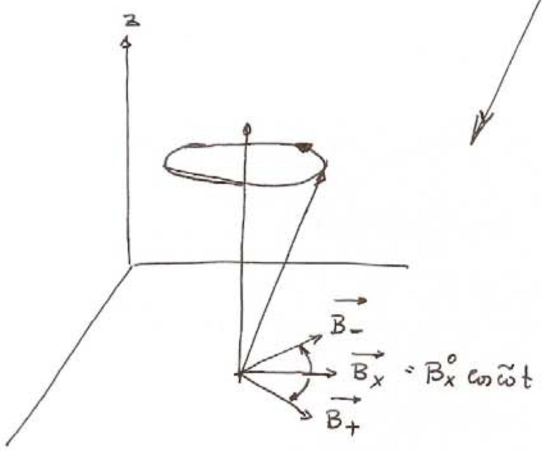
$$\boxed{\omega = \frac{e}{2m} B}$$

EL CAMP NO POT ORIENTAR EL DIPOL.

TRANSICIÓ ENERGÈTICA

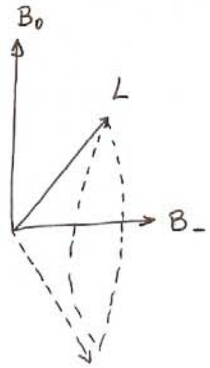


$$\vec{B_x} = \vec{B_+} + \vec{B_-}$$



si $\vec{B_-}$ i $\vec{L}$ estan en repos relatiu

$\Downarrow$



TRANSICIÓ

$$\hat{H} = -g_N\beta_N B(1-\sigma_A)\, I_z^A - g_N\beta_N B\,(1-\sigma_B)\, I_z^B + j\, \vec{I}_A\cdot\vec{I}_B$$

$$\vec{I}_A\cdot\vec{I}_B = I_x^A I_x^B + I_y^A I_y^B + I_z^A I_z^B$$

$$I_x^A I_x^B = \frac{1}{4}\left(I_+^A + I_-^A\right)\left(I_+^B + I_-^B\right) = \frac{1}{4}\left(\cancel{I_+^A I_+^B} + I_+^A I_-^B + I_-^A I_+^B + \cancel{I_-^A I_-^B}\right)$$

$$I_y^A I_y^B = -\frac{1}{4}\left(I_+^A - I_-^A\right)\left(I_+^B - I_-^B\right) = -\frac{1}{4}\left(\cancel{I_+^A I_+^B} - I_+^A I_-^B - I_-^A I_+^B + \cancel{I_-^A I_-^B}\right)$$

$$I_x^A I_x^B + I_y^A I_y^B = \frac{1}{2}\left(I_+^A I_-^B + I_-^A I_+^B\right)$$

$$\boxed{\hat{H} = -g_A B\, I_z^A - g_B B\, I_z^B + \frac{j}{2}\left(I_+^A I_-^B + I_-^A I_+^B + 2 I_z^A I_z^B\right)}$$

$$g_{A/B} = g_N \beta_N (1-\sigma_{A/B})$$

$$\left\{ |\alpha\alpha\rangle \quad |\alpha\beta\rangle \quad |\beta\alpha\rangle \quad |\beta\beta\rangle \right\} \quad \text{BASE}$$

<u>CALCUL ELEMENTS DE MATRIU!</u>

$$\langle \underbrace{\beta_A \alpha_B}| \hat{H} |\underbrace{\alpha_A \beta_B}\rangle = \langle\beta\alpha| \Big\{ \underbrace{-g_A B \tfrac{1}{2}}_{|\alpha\beta\rangle} - \underbrace{g_B B\left(-\tfrac{1}{2}\right)}_{|\alpha\beta\rangle} + \frac{j}{2}\Big(0 + \underbrace{|\beta\alpha\rangle}_{1} + \left(-\tfrac{2}{4}\right)|\alpha\beta\rangle\Big)\Big\}$$

$$\to 0$$

$$= \frac{j}{2}$$

MNR

$g_i = g(1-\sigma_i)$

$\boxed{g_1 = g_2\ ;\ j \neq 0}$

	$\alpha\alpha$	$\alpha\beta$	$\beta\alpha$	$\beta\beta$
$\alpha\alpha$	$2g\beta B_0 + \frac{j}{4}$			
$\alpha\beta$		$-j/4$	$j/2$	
$\beta\alpha$		$j/2$	$-j/4$	
$\beta\beta$				$-2g\beta B_0 + \frac{j}{4}$

	$(\alpha\beta+\beta\alpha)/\sqrt{2}$	$(\alpha\beta-\beta\alpha)/\sqrt{2}$
$\frac{1}{\sqrt{2}}(\alpha\beta+\beta\alpha)$	$j/4$	
$\frac{1}{\sqrt{2}}(\alpha\beta-\beta\alpha)$		$-\frac{3}{4}j$

$\boxed{g_1 \neq g_2\ ;\ j \neq 0}$ CAS GENERAL

	$\alpha\alpha$	$\alpha\beta$	$\beta\alpha$	$\beta\beta$
$\alpha\alpha$	$-(g_1+g_2)\frac{\beta B_0}{2} + \frac{j}{4}$			
$\alpha\beta$		$-(g_1-g_2)\frac{\beta B_0}{2} - \frac{j}{4}$	$j/2$	
$\beta\alpha$		$j/2$	$(g_1-g_2)\frac{\beta B_0}{2} - \frac{j}{4}$	
$\beta\beta$				$(g_1+g_2)\frac{\beta B_0}{2} + \frac{j}{4}$

Δ

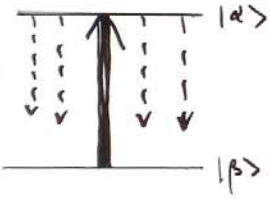
$$\begin{vmatrix} -\Delta-(j/4+E) & j/2 \\ j/2 & \Delta-\underbrace{(j/4+E)}_{\tilde{E}} \end{vmatrix} = \begin{vmatrix} -\Delta-\tilde{E} & j/2 \\ j/2 & \Delta-\tilde{E} \end{vmatrix} = 0 \qquad \tilde{E} = \pm\sqrt{\Delta^2+\frac{j^2}{4}}$$

$$E_1 = -\frac{j}{4} + \sqrt{\Delta^2+\frac{j^2}{4}} \qquad \xrightarrow[(\Delta=0)]{\lim B=0} \qquad j/4 \qquad \alpha\beta+\beta\alpha$$

$$E_2 = -\frac{j}{4} - \sqrt{\Delta^2+\frac{j^2}{4}} \qquad\qquad -3/4\,j \qquad \alpha\beta-\beta\alpha$$

TRANSFORMADA FOURIER

Si $F(\omega)$ i $f(t)$ han de ser reals $\boxed{\text{Def}}$: $\boxed{F(\omega) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{+\infty} f(t) \cos \omega t \, dt}$

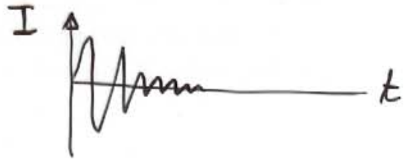


Emissió espontania $-\frac{dN}{dt} = kN$

$\hookrightarrow \boxed{N_t = N_0 \, e^{-kt}}$

▶ Cada atom que es desexcita emet un fotó : REM $I = I_0 \cos \omega_0 t$

▶ La mostra $\begin{cases} I(t) = A \cos \omega_0 t \; e^{-kt} \\ I(t<0) = 0 \end{cases}$



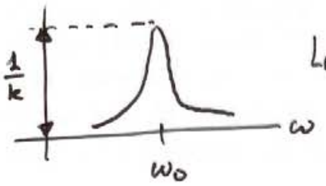
Transformada : $\tilde{I}(\omega) = \frac{1}{\sqrt{2\pi}} \int_0^{\infty} A \cos \omega_0 t \; e^{-kt} \cos \omega t \, dt$

$= \frac{A}{\sqrt{2\pi}} \int_0^{\infty} \frac{1}{2} \left[\cos(\omega+\omega_0)t + \cos(\omega-\omega_0)t \right] e^{-kt} \, dt$; $\int_0^{\infty} \cos ax \; e^{-kx} dx = \frac{k}{a^2+k^2}$

$\uparrow \frac{e^{iax}+e^{-iax}}{2}$

Si $a = \omega + \omega_0$ $\quad \frac{k}{a^2+k^2} \downarrow 0$

Si $a = \omega - \omega_0$ $\quad \frac{k}{a^2+k^2} \Longrightarrow$



Lorentziana

$$\boxed{I(\omega) = \frac{A}{\sqrt{8\pi}} \frac{k}{k^2 + (\omega-\omega_0)^2}}$$

Si $I(t)$ és una mescla $\boxed{I(t) = \sum_i A_i \cos \omega_i t \; e^{-k_i t}} \rightarrow$

$\downarrow$

La transformada és una mescla $\boxed{I(\omega) = \sum_i \frac{A_i}{\sqrt{8\pi}} \frac{k_i}{k_i^2 + (\omega-\omega_i)^2}}$