Föreläsning 6

Boltzman sade:

$$\boxed{P_i = P_1 \cdot e^{-\frac{(E_i - E_1)}{k_B T}}}, \; k_B T \simeq \frac{1}{40}\,eV \quad (\text{rumstemp})$$

$k_B = 1{,}38 \cdot 10^{-23}\,J/K$

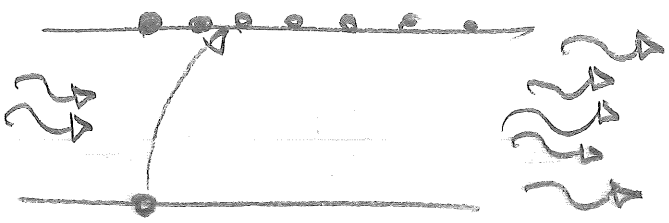
$$\frac{P_2}{P_1} = e^{-\frac{E_2 - E_1}{k_B T}} = \boxed{4 \cdot 10^{-176}}$$

$E_2 = 13{,}6$, $E_1 = -3{,}4$

Rä

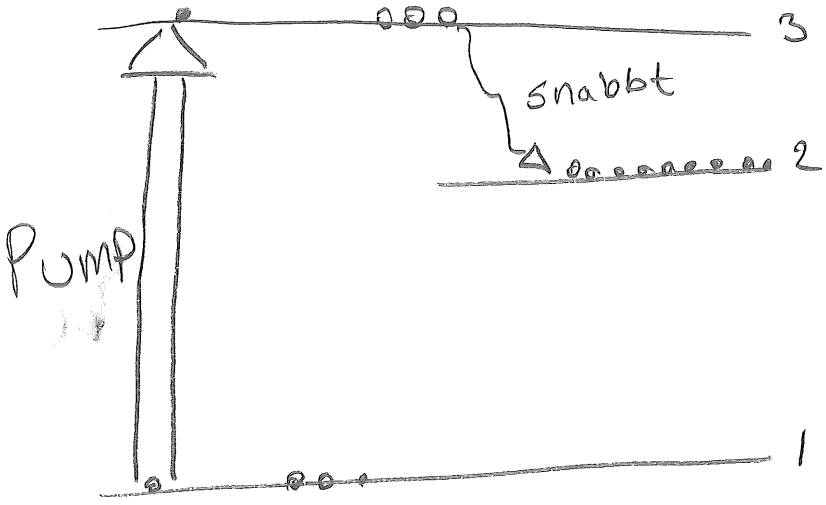
Remember laser 3s bakåt.
Sannolikheten att stim. emiss och stim. abs är lika!

så



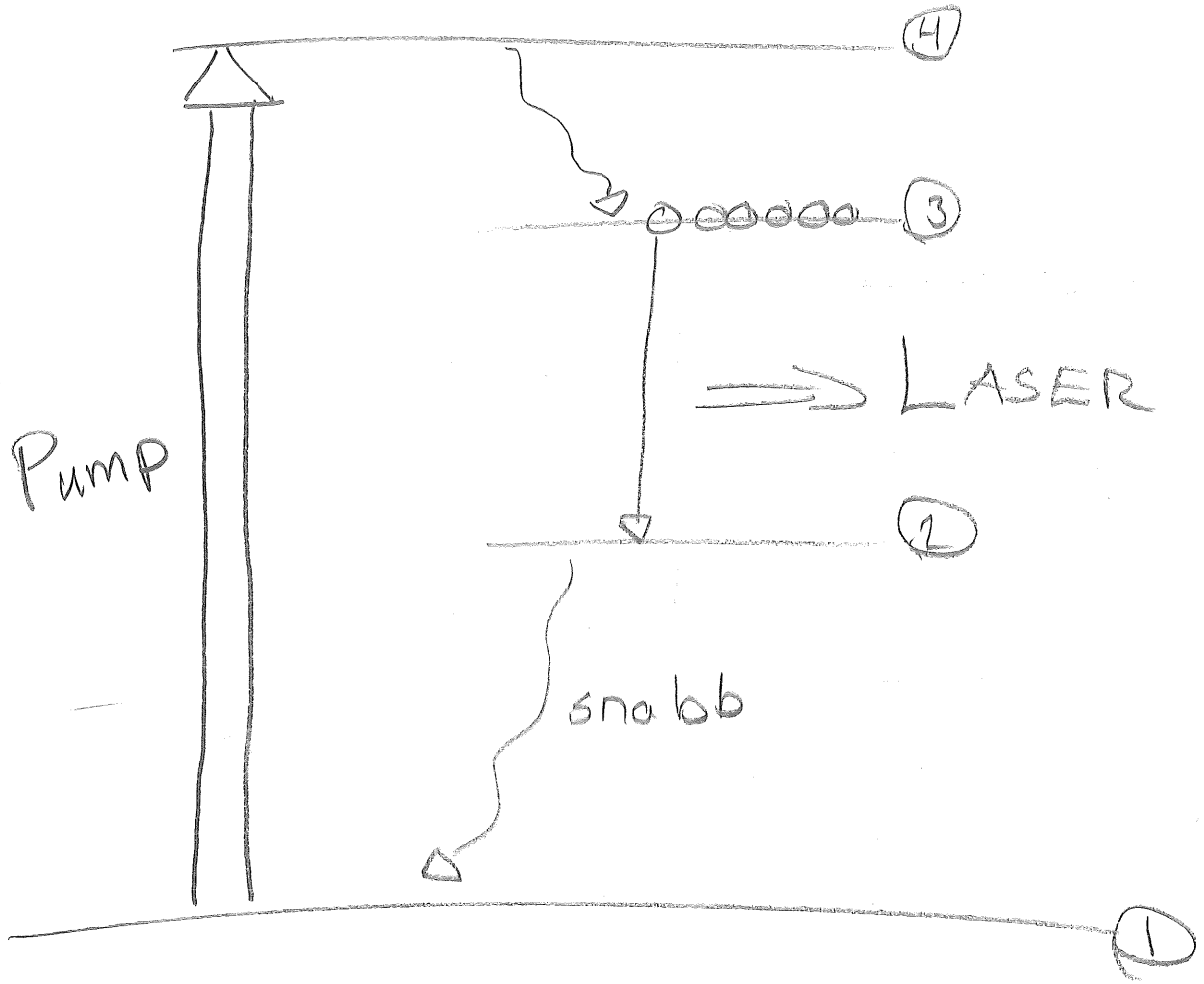
gör ej!

Lika mkt kommer ju absorbas.



$N_2 > N_1$ (bra!)

Fyrnivåsystem

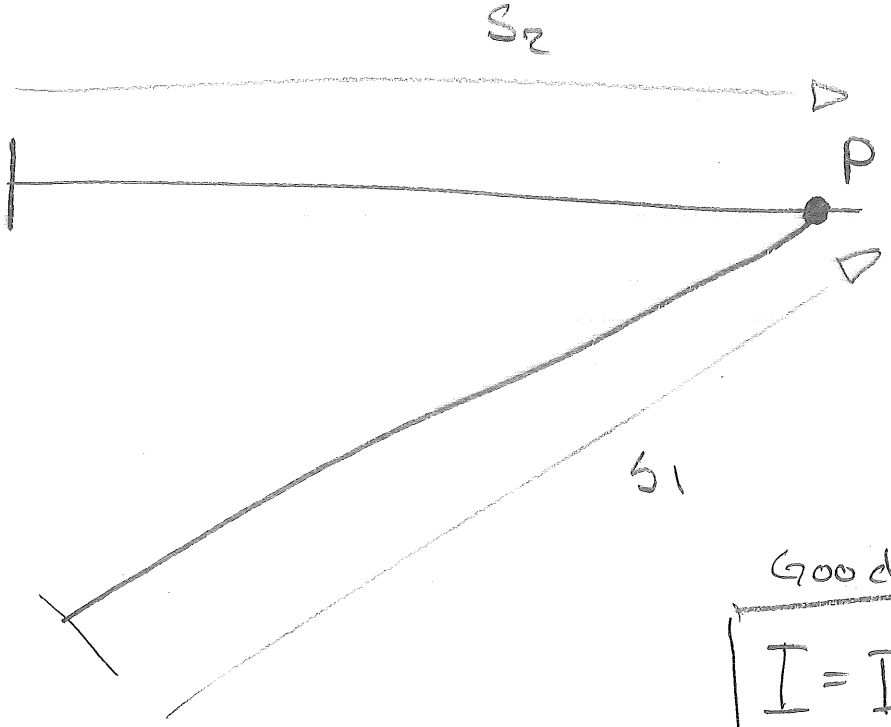


Laser uppkommer när man har fler elektoner i 3:an än 2:an.

Resten av laserfysiken ligger utanför kursen!

Diffraktion och Interferens

böjning))))) addition))))) KAOS.



Good to know!

$$I = I_1 + I_2 + I_{12}$$

$$E_1 = E_{01}\cos(ks_1 - \omega t + \phi_1)$$

$$E_2 = E_{02}\cos(ks_2 - \omega t + \phi_2)$$

Superpositionsprincipen

$$E_p = E_1 + E_2$$

medelvärdet

Intensiteten: $I = \varepsilon_0 c \langle E \cdot E \rangle = \varepsilon_0 c \langle (E_1 + E_2)\cdot(E_1 + E_2) \rangle$

interferens!

$$I = \varepsilon_0 c \langle \underbrace{E_1 \cdot E_1}_{I_1} + \underbrace{E_2 E_2}_{I_2} + \overbrace{2 E_1 \cdot E_2}^{\text{interferens!}} \rangle$$

$$I_{12} = 2\varepsilon_0 c \langle \vec{E}_1 \cdot \vec{E}_2 \rangle$$

$\vec{E}_1 \perp \vec{E}_2$ (termen = 0, skalprod)

$$\vec{E}_1 \cdot \vec{E}_2 = \vec{E}_{01} \cdot \vec{E}_{02} \cos(ks_1 - \omega t + \phi_1) \cos(ks_2 - \omega t + \phi$$

$$\alpha = ks_1 + \phi_1$$
$$\beta = ks_2 + \phi_2$$

$$\Rightarrow 2\vec{E}_1 \cdot \vec{E}_2 = 2\vec{E}_{01} \cdot \vec{E}_{02} \cos(\alpha - \omega t) \cos(\beta - \omega t)$$

trick: $2\cos(A)\cos(B) = \cos(A+B) + \cos(B-A)$

så:

$$2\langle \vec{E}_1 \cdot \vec{E}_2 \rangle = E_{01} E_{02} \left[\underbrace{\langle \cos(\alpha + \beta - 2\omega t) \rangle}_{=0} + \langle \cos(\beta - \alpha) \rangle \right]$$

WHY?

$$= E_{01} E_{02} \langle \cos(\beta - \alpha) \rangle = \quad \delta = \beta - \alpha = k(s_2 - s_1) + \phi_2 - \phi_1$$

$$= E_{01} E_{02} \langle \cos\delta \rangle$$

$$\boxed{I_{12} = \varepsilon_0 c E_{01} E_{02} \langle \cos\delta \rangle}$$

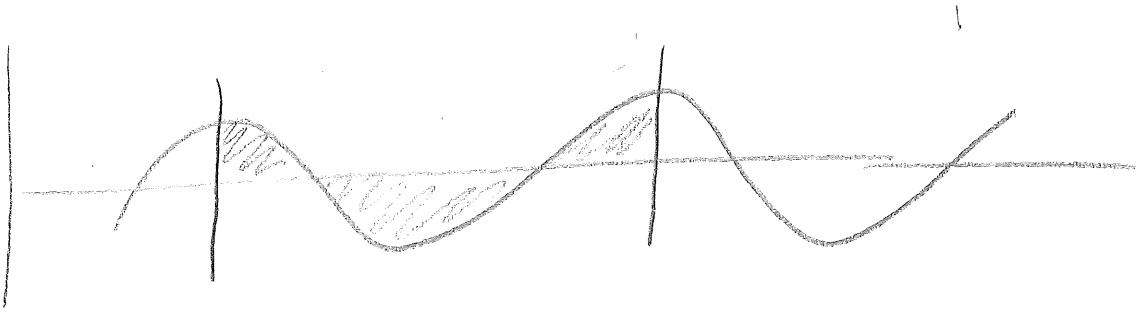
$$I_1 = \varepsilon_0 c \langle \vec{E}_1 \cdot \vec{E}_1 \rangle = \varepsilon_0 c E_{01}^2 \underbrace{\langle \cos^2(\alpha - \omega t) \rangle}_{=\frac{1}{2}}$$

$$= \boxed{\frac{1}{2} \varepsilon_0 c E_{01}^2}$$

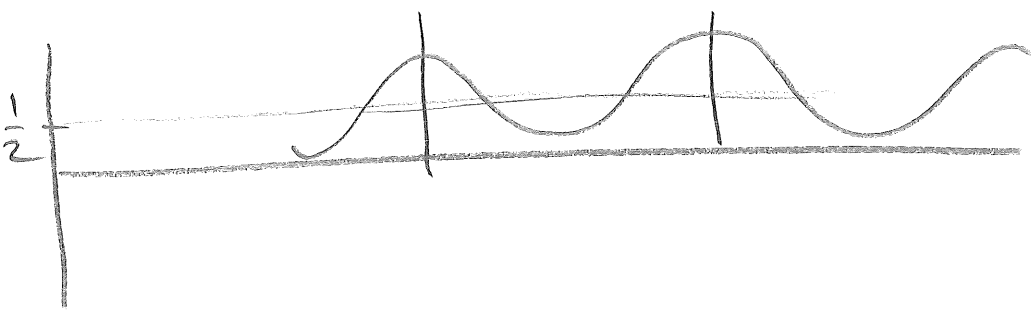
$$\boxed{I_2 = \frac{1}{2} \varepsilon_0 c E_{02}^2}$$

$$E_1 \parallel E_2 : \quad I_{12} = 2\sqrt{I_1 I_2} \langle \cos \delta \rangle$$

MEDELVÄRDE! $\langle \cos \omega t \rangle = 0$



$$\langle \cos^2 \omega t \rangle = \frac{1}{2}$$



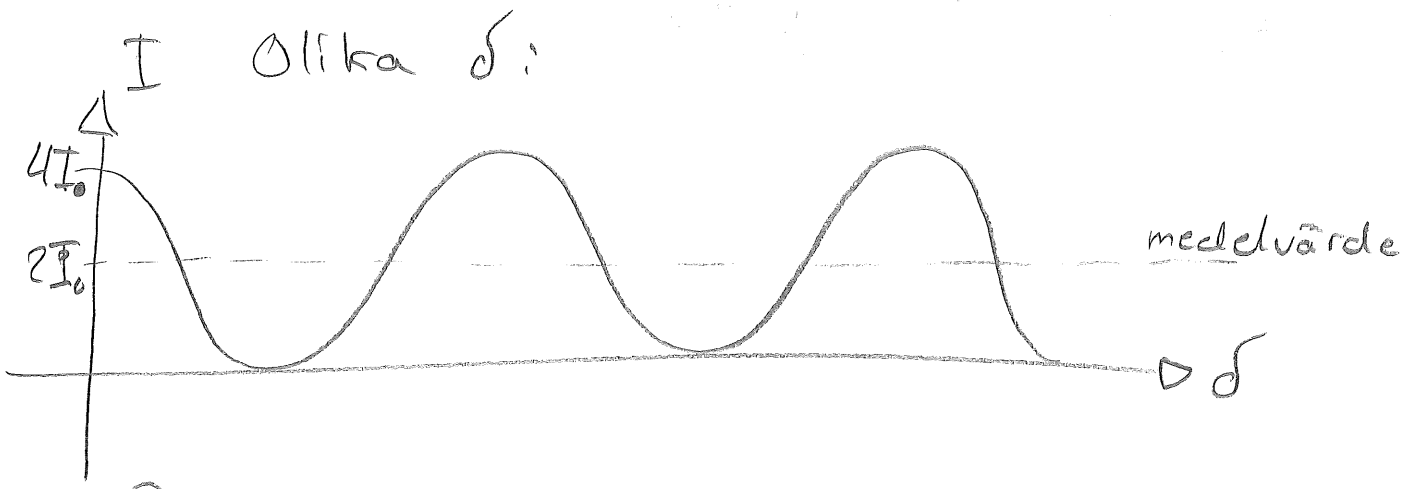
Hur mycket varierar I?

$\cos\delta = 1 \Rightarrow I_{max} = I_1 + I_2 + 2\sqrt{I_1 I_2}$ $\quad \delta = 2\pi \cdot n$

$\cos\delta = -1 \Rightarrow I_{min} = I_1 + I_2 - 2\sqrt{I_1 I_2}$ $\quad \delta = (2n+1)\pi$

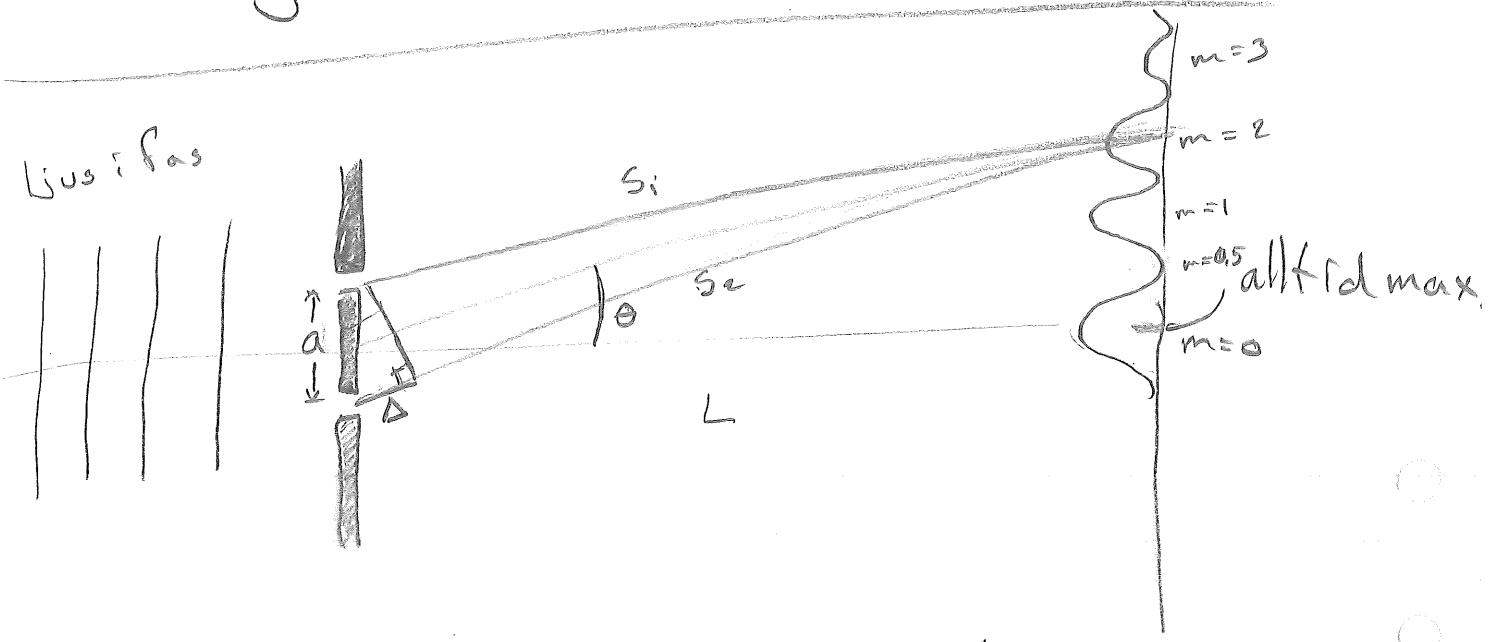
- Samma intensitet $I_1 = I_2 = I_0$
- $I_{max} = I_0 + I_0 + 2\sqrt{I_0 I_0} = \boxed{4I_0}$ — $\boxed{1+1=4}$
- $I_{min} = I_0 + I_0 - 2\sqrt{I_0^2} = \underline{0}$ WHAAY?

I olika δ:



Vi fördelar energin.

Youngs dubbelspaltexperiment.



$L >> a \Rightarrow s_2 - s_1 = \Delta = m\lambda$ (vid konstruktiv interferens)

$\Delta = a \sin\theta$

$a \sin\theta = m\lambda$ (max)

$a \sin\theta = (m+\frac{1}{2})\lambda$ (min)

$\delta = k(s_2 - s_1) = \frac{2\pi}{\lambda}\Delta$