

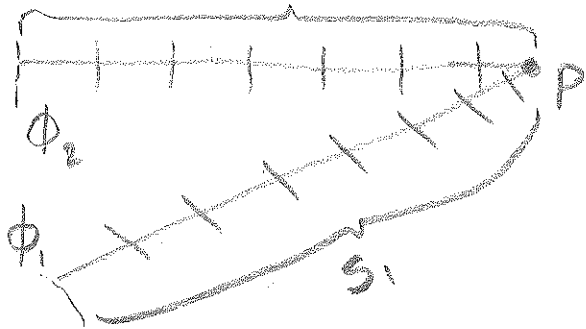
# Föreläsning 6 08/04-15

Superpositionsprincipen

- Två vågor kan adderas.

Diffraction och interferens

Interferens mellan ljudvågor med samma frekvens



$$\vec{E}_1 = \vec{E}_{01} \cos(ks_1 - \omega t + \phi_1)$$

$$\vec{E}_2 = \vec{E}_{02} \cos(ks_2 - \omega t + \phi_2)$$

Superpositionsprincipen

$$\vec{E}_P = \vec{E}_1 + \vec{E}_2$$

Intensitet:  $I = \epsilon_0 c \langle \vec{E} \cdot \vec{E} \rangle$

$$\begin{aligned} \Rightarrow \epsilon_0 c \langle \vec{E}_P \cdot \vec{E}_P \rangle &= \epsilon_0 c \langle (\vec{E}_1 + \vec{E}_2) \cdot (\vec{E}_1 + \vec{E}_2) \rangle = \\ &= \epsilon_0 c \langle \underbrace{\vec{E}_1 \cdot \vec{E}_1}_{I_1} + \underbrace{\vec{E}_2 \cdot \vec{E}_2}_{I_2} + \underbrace{2\vec{E}_1 \cdot \vec{E}_2}_{\text{Interferens term}} \rangle \end{aligned}$$

↑ tidsmedelv

$> 0, < 0$

$$I_P = I_1 + I_2 + \underbrace{I_{12}}_{\text{vågegenskap}}$$

$$I_{12} = 2\epsilon_0 c \langle \vec{E}_1 \cdot \vec{E}_2 \rangle$$

$$\text{om } \vec{E}_1 \perp \vec{E}_2 \Rightarrow I_{12} = 0$$

men om  $\vec{E}_1 \parallel \vec{E}_2$

$$\vec{E}_1 \cdot \vec{E}_2 = \vec{E}_{01} \cdot \vec{E}_{02} \cos(ks_1 - \omega t + \phi_1) \cos(ks_2 - \omega t + \phi_2)$$

$$\alpha = ks_1 + \phi_1$$

$$\beta = ks_2 + \phi_2$$

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

Samla alla  $t$

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

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

$$= \bar{E}_{01} \cdot \bar{E}_{02} \langle \cos(\beta - \alpha) \rangle = \bar{E}_{01} \cdot \bar{E}_{02} \langle \cos \delta \rangle$$

$$\text{Om } \delta = \beta - \alpha = k(s_2 - s_1) + \phi_2 - \phi_1$$

$$I_{12} = \epsilon_0 c \bar{E}_{01} \cdot \bar{E}_{02} \langle \cos \delta \rangle$$

$$I_1 = \epsilon_0 c \langle \bar{E}_1 \cdot \bar{E}_1 \rangle = \epsilon_0 c E_{01}^2 \langle \cos^2(\alpha - \omega t) \rangle = \frac{1}{2} \epsilon_0 c E_{01}^2$$

$$I_2 = \frac{1}{2} \epsilon_0 c E_{02}^2$$

$$\text{Om } \bar{E}_1 \parallel \bar{E}_2$$

$$\Rightarrow I_{12} = 2 \sqrt{I_1 I_2} \langle \cos \delta \rangle$$

$$\Rightarrow I_p = I_1 + I_2 + 2 \sqrt{I_1 I_2} \langle \cos \delta \rangle$$

$$\langle \cos \delta \rangle = 1$$

$$I_{\max} = I_1 + I_2 + 2 \sqrt{I_1 I_2}, \delta = 2m\pi$$

$$\langle \cos \delta \rangle = -1$$

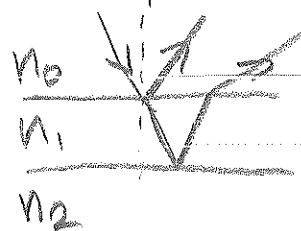
$$I_{\min} = I_1 + I_2 - 2 \sqrt{I_1 I_2}, \delta = (2m+1)\pi$$

$$\text{Samma intensitet } I_1 = I_2 = I_0$$

$$\Rightarrow I_{\max} = I_0 + I_0 + 2I_0 = 4I_0$$

$$I_{\min} = I_0 + I_0 - 2I_0 = 0$$

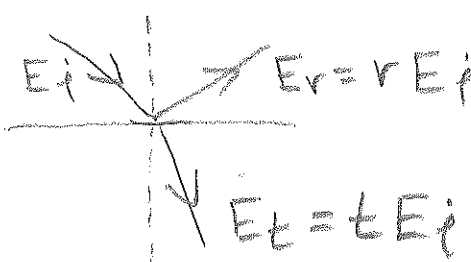
Interferens i tunna skikt



The diagram shows three horizontal lines representing media with refractive indices  $n_0$ ,  $n_1$ , and  $n_2$ . An incident ray from  $n_0$  hits the  $n_0/n_1$  interface. Part of it reflects back into  $n_0$ , and part refracts into  $n_1$ . At the  $n_1/n_2$  interface, part reflects back into  $n_1$  and part refracts into  $n_2$ .

$$r = \frac{1-n}{1+n} \quad r = \frac{E_r}{E_i}, \quad t = \frac{E_t}{E_i}$$

Stokes relationer



The diagram shows a vertical interface between two media. An incident ray  $E_i$  from the left hits the interface. A reflected ray  $E_r$  goes back to the left, and a transmitted ray  $E_t$  goes to the right.

$$E_r = r E_i \quad \text{Samma när ljuset går omvänt}$$

$$E_t = t E_i$$