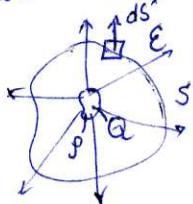


Справедливи коеркуцијенти

Максвелове јединице

$$\textcircled{1} \quad \Phi_{lux} = Q_{us}$$



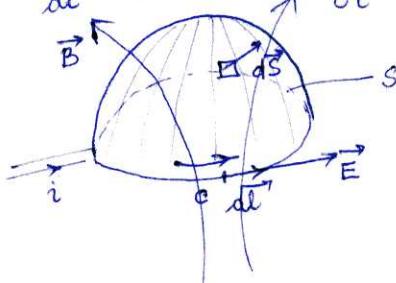
Гаусов закон

$$\oint_S \vec{E} \cdot d\vec{S} = \int_V \rho dV$$

$$\oint_C \vec{E} \cdot d\vec{l} = 0$$

$$\operatorname{div} \vec{D} = \rho$$

$$\textcircled{2} \quad I_{ms} = - \frac{d\Phi}{dt} \quad \text{извршито} = - \frac{\partial \Phi}{\partial t} (x, y, z, t) \quad \text{Справедлив закон}$$



$$\oint_C \vec{E}_{ind} \cdot d\vec{l} = - \frac{\partial}{\partial t} \int_S \vec{B} \cdot d\vec{S}$$

$$\vec{E} = \vec{E}_{ind} + \vec{E}_{st.}$$

$$\oint_C \vec{E} \cdot d\vec{l} = - \frac{\partial}{\partial t} \int_S \vec{B} \cdot d\vec{S}$$

$$\textcircled{3} \quad \text{Амперов закон}$$

$$\oint_C \vec{H} \cdot d\vec{l} = i = \int_S \vec{j} \cdot d\vec{S}; \quad \text{нпрекајуши} \quad \int_S (\vec{j} + \frac{\partial \vec{D}}{\partial t}) \cdot d\vec{S}$$

Максвелова
скупја
импреза

$$\textcircled{4} \quad \text{Закон коеркуције срујка}$$

$$\oint_S \vec{B} \cdot d\vec{S} = 0$$

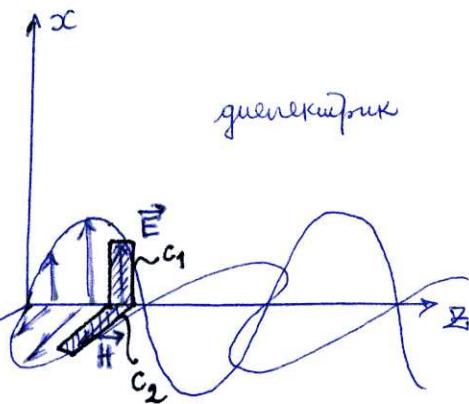
$$\operatorname{div} \vec{B} = 0$$

1(8)

За нелектрическите $j=0$

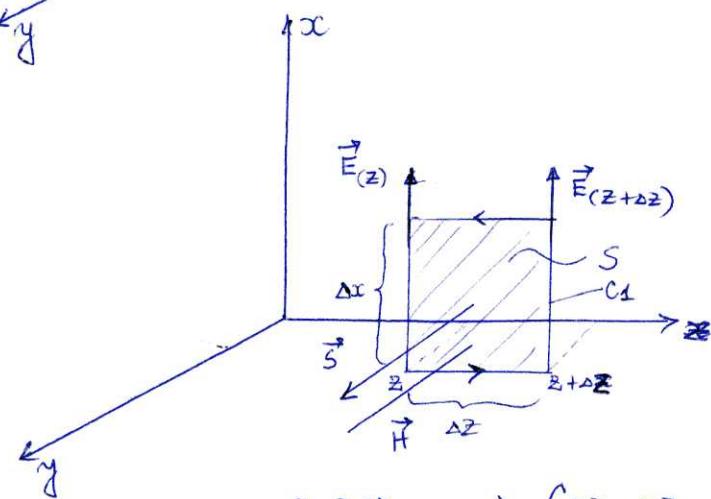
Ампere закон у поканството единици $\vec{J} = \sigma \cdot \vec{E}$

изходният вектор



$$E_{xz} = E_0 \sin(\omega t - kx + \varphi)$$

$$H_y = H_0 \sin(\omega t - kx + \varphi)$$



$$\oint_C \vec{E} d\ell = - \frac{\partial}{\partial t} \int_S \vec{B} \cdot d\vec{S}$$

$$\mu H \Delta x \Delta z j$$

$$[E(z+\Delta z) - E(z)] \Delta x = - \frac{\partial}{\partial t} \mu H \frac{\Delta x}{\cancel{\Delta z}} \cancel{\Delta z}$$

$$\frac{E(z+\Delta z) - E(z)}{\Delta z} = - \mu \frac{\partial H}{\partial t} / \lim_{\Delta z \rightarrow 0}$$

$$\frac{\partial E}{\partial z} = - \mu \frac{\partial H}{\partial t} \rightarrow \text{jе изтегленето на тангенциални параметри EMT.}$$

2(8)

$$\textcircled{1} \quad \frac{\partial E}{\partial z} = -\mu \frac{\partial H}{\partial t}$$

Жегтагиметтознанты радиотехника ЕМ шанас.

$$E = E_0 \sin(\omega t - kz)$$

$$H = H_0 \sin(\omega t - kz)$$



3. максималда жегтасы:

$$\oint_{C_i} \vec{H} \cdot d\vec{l} = H(z) \cdot \Delta y - H(z+\Delta z) \cdot \Delta y =$$

$$= \frac{\partial}{\partial t} \int_S D \cdot d\vec{S} = \frac{\partial}{\partial t} (\Delta y \Delta z \epsilon E)$$

$$-\frac{H(z+\Delta z) - H(z)}{\Delta z} = \epsilon \frac{\partial}{\partial t} E \quad / \lim_{\Delta z \rightarrow 0}$$

$$\textcircled{2} \quad -\frac{\partial H}{\partial z} = \epsilon \frac{\partial E}{\partial t}$$

$$\textcircled{1} / \frac{\partial}{\partial z} \text{ и } \textcircled{2} / \frac{\partial}{\partial t}$$

$$\frac{\partial^2 E}{\partial z^2} = -\mu \frac{\partial^2 H}{\partial t \partial z} \quad \text{и} \quad -\frac{\partial^2 H}{\partial z \partial t} = \epsilon \frac{\partial^2 E}{\partial t^2}$$

$$\frac{\partial^2 E}{\partial z^2} = (\epsilon \mu) \frac{\partial^2 E}{\partial t^2}$$

$$\frac{\partial^2 H}{\partial z \partial t} = \frac{\partial^2 H}{\partial z \partial t}$$

Важни за константууларды

$$\frac{\partial^2 H}{\partial z^2} = \epsilon \mu \frac{\partial^2 H}{\partial t^2}$$

$$n_f = \frac{1}{\sqrt{\epsilon \mu}}$$

Боршта ЕМ шанаса
үйнелекштерикүү

$$\frac{1}{\sqrt{\epsilon \mu}} = \frac{1}{\sqrt{\epsilon_r \epsilon_0 \mu_r \mu_0}} = \frac{1}{\sqrt{\epsilon_r \mu_r}} \cdot \frac{1}{\sqrt{\epsilon_0 \mu_0}} = \frac{c}{\sqrt{\epsilon_r \mu_r}} \Rightarrow \frac{c}{n_f} \triangleq n$$

$$n = \sqrt{\epsilon_r \mu_r}$$

За үйнелекштерик $n \approx \sqrt{\epsilon_r}$

$$E = E_0 \sin(\omega t - kz)$$

$$H = H_0 \sin(\omega t - kz)$$

№3
① $\frac{\partial E}{\partial z} = -k E_0 \omega (\omega t - kz)$

$$\frac{\partial H}{\partial t} = \omega H_0 \cos(\omega t - kz)$$

$$-k E_0 \cos(\omega t - kz) = -\mu \omega H_0 \cos(\omega t - kz)$$

$$E_0 = \mu \cdot \frac{\omega}{k} H_0$$

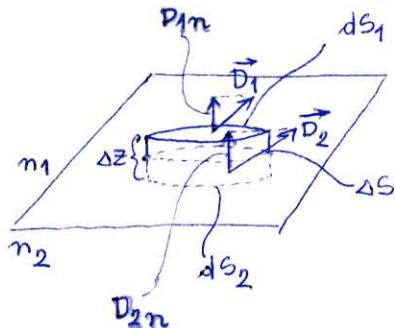
$$n_f = \frac{1}{\sqrt{\epsilon \mu}} = \sqrt{\frac{\mu}{\epsilon}} H_0 / \sin(\omega t - kz)$$

$$\sqrt{\epsilon} E = \sqrt{\mu} H$$

$$Z = \frac{E}{H} = \sqrt{\frac{\mu}{\epsilon}} \quad \text{мнігатса спрощте}$$

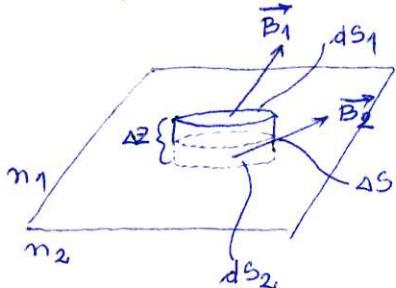
$$Z_0 = \sqrt{\frac{\mu_0}{\epsilon_0}} \approx 377 \Omega \quad \text{мнігатса барууда}$$

Веза компонентите електромагнитной волны на разглобиттој и обрни
2. генераторика

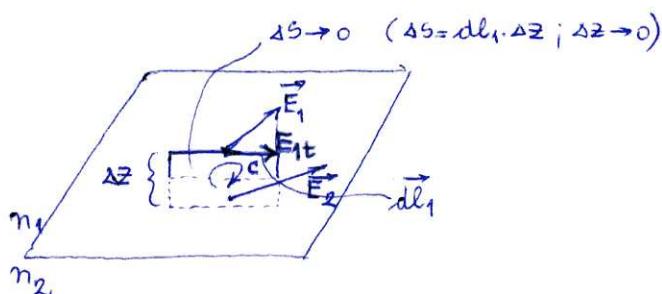


1. Максвелла j. $\oint \vec{D} d\vec{S} = 0$
 $D_1 \cdot dS_1 + D_2 \cdot dS_2 + D_0 \cdot dS_0 = 0$
 $\Delta S \rightarrow 0$
 Аддекартична интеграция
 на оношану и обрни ΔS

$$D_{1n} - \text{Нормална компонента ел. поля в 1-ом} \Rightarrow D_{1n} = D_{2n} \Rightarrow E_1 E_{1n} = E_2 E_{2n}$$



4. Максвелла j. $H_{1n} = H_{2n}$
 $\frac{B_{1n}}{\mu_1} = \frac{B_{2n}}{\mu_2}$
 $\mu_1 = \mu_2 = \mu_0 - \text{за генераторика}$
 $B_{1n} = B_{2n}$



2. Максвелла j.

$$\oint \vec{E} d\vec{l} = \vec{E}_1 d\vec{l}_1 + \vec{E}_2 d\vec{l}_2 = 0$$

$$\vec{E}_1 d\vec{l}_1 = - \vec{E}_2 d\vec{l}_2$$

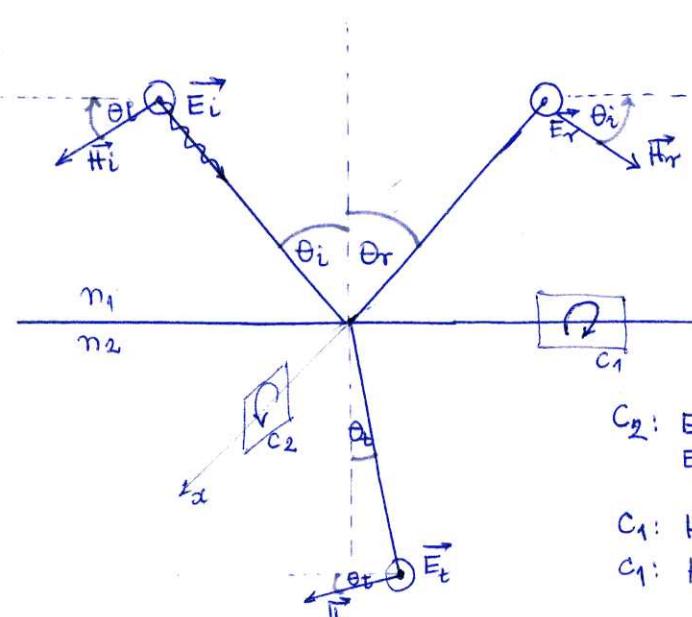
$$E_{1t} = E_{2t}$$

3. Максвелла j.

$$\oint \vec{H} d\vec{l} = 0 \quad (\Delta S \rightarrow 0)$$

$$H_{1t} = H_{2t} \quad 4(8)$$

Прилесферзантната енергийчка идификация



$$\theta_i = \theta_r$$

$$C_2: E_{1t} = E_{2t}$$

$$E_i + E_r = E_t \quad (1)$$

$$C_1: H_1 \cos \theta_i + H_2 \cos \theta_i = H_t \cos \theta_t \quad (2)$$

$$C_1: H_{1t} = H_{2t}$$

$$(1) \Rightarrow 1 + r^{TE} = t^{TE} \quad [1]$$

$$\frac{E_r}{E_i} \quad \frac{E_t}{E_i}$$

$$(2) \Rightarrow H_i = \sqrt{\frac{\epsilon_i}{\mu}} E_i$$

$$H_r = \sqrt{\frac{\epsilon_i}{\mu}} E_r$$

$$H_t = \sqrt{\frac{\epsilon_2}{\mu}} E_t$$

$$1 - r^{TE} = \frac{n_2}{n_1} \cdot \frac{\cos \theta_t}{\cos \theta_i} t^{TE} \quad [2]$$

$$\text{из } [1] \text{ и } [2] \Rightarrow 1 - r^{TE} = \frac{\sin \theta_i}{\sin \theta_t} \cdot \frac{\omega \theta_t}{\omega \theta_i} t^{TE}$$

$$1 + r^{TE} = t^{TE}$$

$$r^{TE} = t^{TE} - 1 = \frac{2 \sin \theta_t \cos \theta_i - \sin(\theta_i + \theta_t)}{\sin(\theta_t + \theta_i)} =$$

$$2 = t^{TE} \left(1 + \frac{\sin \theta_i \cos \theta_t}{\sin \theta_t \cos \theta_i} \right) = \frac{\sin \theta_t \cos \theta_i - \sin \theta_i \cos \theta_t}{\sin(\theta_t + \theta_i)}$$

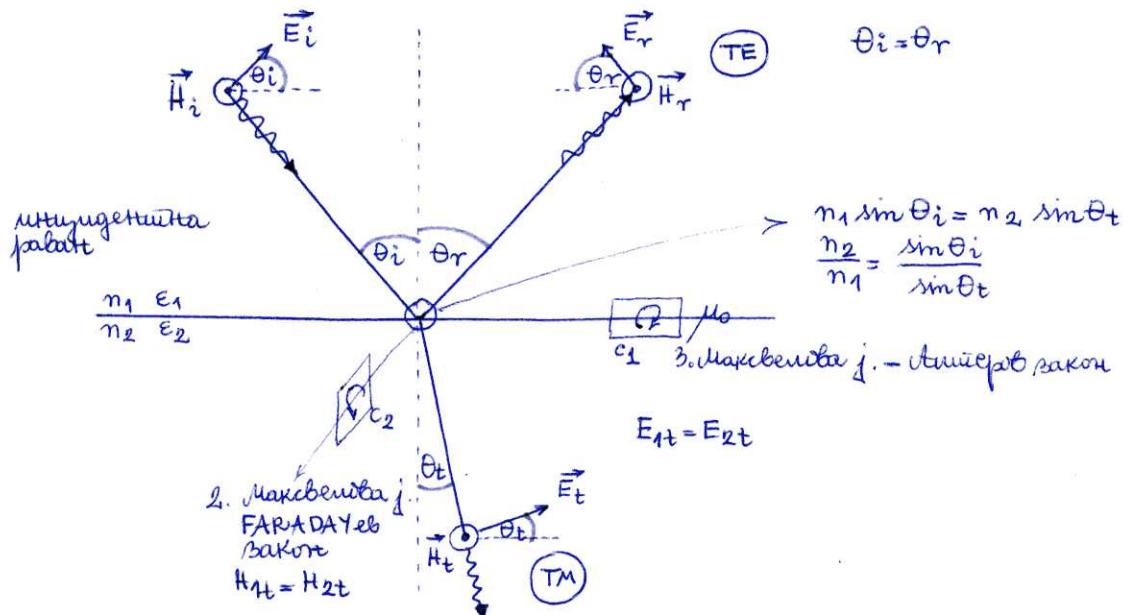
$$t^{TE} = \frac{2 \sin \theta_t \cos \theta_i}{\sin \theta_t \cos \theta_i + \sin \theta_i \cos \theta_t}$$

$$t^{TE} = \frac{2 \sin \theta_t \cos \theta_i}{\sin(\theta_i + \theta_t)} > 0$$

$$r^{TE} = \frac{\sin(\theta_t - \theta_i)}{\sin(\theta_t + \theta_i)} > 0$$

$$\theta_i > \theta_t \Rightarrow r^{TE} < 0 \quad 5(8)$$

Преносерганто математска понарканизација
(преносерганто математичко име)



$$E_{1t} = E_{2t} = E_t \cos \theta_t$$

$$E_i \cos \theta_i - E_r \cos \theta_i = E_t \cos \theta_t \quad / : E_i \cos \theta_i$$

$$1 - \left(\frac{E_r}{E_i} \right) = \left(\frac{E_t}{E_i} \right) \cdot \frac{\cos \theta_t}{\cos \theta_i}$$

$$\gamma^{TM} \triangleq \frac{E_r}{E_i}$$

$$t^{TM} \triangleq \frac{E_t}{E_i}$$

$$H_{1t} = H_{2t}$$

$$\underbrace{H_i}_{\parallel} + \underbrace{H_r}_{\parallel} = \underbrace{H_t}_{\parallel} \quad / : E_i$$

$$\sqrt{\frac{\epsilon_1}{\mu}} E_i + \sqrt{\frac{\epsilon_1}{\mu}} E_r = \sqrt{\frac{\epsilon_2}{\mu}} E_t$$

$$\sqrt{\frac{\epsilon_1}{\mu}} (1 + \gamma^{TM}) = \sqrt{\frac{\epsilon_2}{\mu}} t^{TM}$$

$$1 + \gamma^{TM} = \frac{n_2}{n_1} t^{TM} \quad (2) \quad \frac{n_2}{n_1} = \frac{\sin \theta_i}{\sin \theta_t}$$

$$1 - \gamma^{TM} = \frac{\cos \theta_t}{\cos \theta_i} t^{TM} \quad (1)$$

$$\textcircled{1} + \textcircled{2} \Rightarrow 1+r^{TM} + 1-r^{TM} = \frac{\sin \theta_i}{\sin \theta_t} t^{TM} + \frac{\cos \theta_i}{\cos \theta_t} t^{TM}$$

$$t_i = t^{TM} \frac{\sin \theta_i \cos \theta_i + \sin \theta_t \cos \theta_t}{\sin \theta_t \cos \theta_i}$$

$$t^{TM} = \frac{2 \sin \theta_t \cos \theta_i}{\sin \theta_i \cos \theta_i (\sin^2 \theta_t + \cos^2 \theta_t) + \sin \theta_t \cos \theta_t (\sin^2 \theta_i + \cos^2 \theta_i)}$$

$$t^{TM} = \frac{2 \sin \theta_t \cos \theta_i}{\underbrace{\sin \theta_i \cos \theta_i}_{\sin \theta_t \cos \theta_t} \underbrace{\sin^2 \theta_t + \sin \theta_i \cos \theta_i \cos^2 \theta_t}_{\sin \theta_t \cos \theta_t \sin^2 \theta_i + \sin \theta_t \cos \theta_t \cos^2 \theta_i}}$$

$$t^{TM} = \frac{2 \sin \theta_t \cos \theta_i}{\underbrace{\sin \theta_t \cos \theta_i}_{\sin \theta_t \cos \theta_t} (\underbrace{\cos \theta_t \cos \theta_i + \sin \theta_t \sin \theta_i}_{\cos \theta_t \cos \theta_i + \sin \theta_t \sin \theta_i}) + \underbrace{\sin \theta_i \cos \theta_t}_{\sin \theta_t \cos \theta_t} (\underbrace{\cos \theta_i \cos \theta_t + \sin \theta_i \sin \theta_t}_{\cos \theta_i \cos \theta_t + \sin \theta_i \sin \theta_t})}$$

$$t^{TM} = \frac{2 \sin \theta_t \cos \theta_i}{(\sin \theta_i \cos \theta_t + \sin \theta_t \cos \theta_i) (\cos \theta_t \cos \theta_i + \sin \theta_t \sin \theta_i)}$$

$$t^{TM} = \frac{2 \sin \theta_t \cos \theta_i}{\sin (\theta_i + \theta_t) \cos (\theta_i - \theta_t)} > 0$$

$$r^{TM} = \frac{m_2}{m_1} t^{TM} - 1 = \frac{\sin \theta_i}{\sin \theta_t} \cdot t^{TM} - 1 = \frac{\sin \theta_i}{\sin \theta_t} \cdot \frac{2 \sin \theta_t \cos \theta_i}{\sin (\theta_i + \theta_t) \cos (\theta_i - \theta_t)} - 1 =$$

$$= \frac{2 \sin \theta_i \cos \theta_i - \sin (\theta_i + \theta_t) \cos (\theta_i - \theta_t)}{\sin (\theta_i + \theta_t) \cos (\theta_i - \theta_t)} =$$

$$= \frac{\sin 2\theta_i - \frac{1}{2} (\sin (\theta_i + \theta_t + \theta_i - \theta_t) + \sin (\theta_i + \theta_t + \theta_t - \theta_i))}{\sin (\theta_i + \theta_t) \cos (\theta_i - \theta_t)} =$$

$$= \frac{\sin 2\theta_i - \frac{1}{2} \sin 2\theta_i - \frac{1}{2} \sin 2\theta_t}{\sin (\theta_i + \theta_t) \cos (\theta_i - \theta_t)} =$$

$$= \frac{\frac{1}{2} (\sin 2\theta_i - \sin 2\theta_t)}{\sin (\theta_i + \theta_t) \cos (\theta_i - \theta_t)} = \frac{2 \cdot \frac{1}{2} \cdot \frac{\sin 2\theta_i + 2\theta_t}{2} \sin \frac{2\theta_i - 2\theta_t}{2}}{\sin (\theta_i + \theta_t) \cos (\theta_i - \theta_t)} =$$

$$= \frac{\sin (\theta_i - \theta_t) \cos (\theta_i + \theta_t)}{\sin (\theta_i + \theta_t) \cos (\theta_i - \theta_t)} \Rightarrow$$

$$\Rightarrow r^{TM} = \frac{\operatorname{tg} (\theta_i - \theta_t)}{\operatorname{tg} (\theta_i + \theta_t)} \geq 0$$

$\theta_t > \theta_i \Rightarrow r^{TM} < 0$ ојаките фазе налага за π

$$\frac{n_1}{n_2} = \frac{\sin \theta_t}{\sin \theta_i} > 1 \Rightarrow n_1 > n_2$$

$$\tan(\theta_i + \theta_t) = \infty \Rightarrow r_B^{TM} = 0$$

$\theta_i + \theta_t = \frac{\pi}{2}$ јасно за Б्रујстеров удео

$$\theta_t = \frac{\pi}{2} - \theta_i$$

$$n_1 \sin \theta_i = n_2 \sin \theta_t = n_2 \sin\left(\frac{\pi}{2} - \theta_i\right)$$

$$\tan \theta_{iB} = \frac{n_2}{n_1} \quad \text{BREWSTEROV удео} \quad (\text{јасно само TM ионизација})$$

$$R^{TM} = (r^{TM})^2 \sim I^{TM} \quad (\text{интензитет рефлектиране светлости})$$

Светлост која има једнак саопштавј ТМ и TE ионизације:

$$R = \frac{1}{2} R^{TM} + \frac{1}{2} R^{TE}$$
$$T = \frac{1}{2} T^{TM} + \frac{1}{2} T^{TE}$$
$$\theta_i = 0 \quad \frac{n=1}{\overbrace{n_2}^{\downarrow}} \quad \overbrace{\quad}^{\uparrow}$$
$$T^{TM} = (t^{TM})^2$$

$$r^{TM} = \frac{(n-1)^2}{(n+1)^2}$$

пример: стакло $n = 1.5$
 $\Rightarrow r^{TM} \approx 4\%$