1) $\bar{E}_{1\parallel}+\bar{E}_{3\parallel}=\bar{E}_{3\parallel}$

2) $\varepsilon_1\bar{E}_{1\perp}+\varepsilon_1\bar{E}_{1\perp}=\varepsilon_2\bar{E}_{2\perp}$

3) $\frac{1}{\mu_1}(\bar{k}_1\times\bar{E}_1)_\parallel+\frac{1}{\mu_1}(\bar{k}_3\times\bar{E}_3)_\parallel=\frac{1}{\mu_2}(\bar{k}_2\times\bar{E}_2)_\parallel$

4) $(\bar{k}_1\times\bar{E}_1)_\perp+(\bar{k}_3\times\bar{E}_3)_\perp=(\bar{k}_2\times\bar{E}_2)_\perp$

$\bar{B}_i=\frac{1}{\mu_0}(\bar{k}_i\times\bar{E}_i)$

$n_i^2=\varepsilon_i\mu_i$

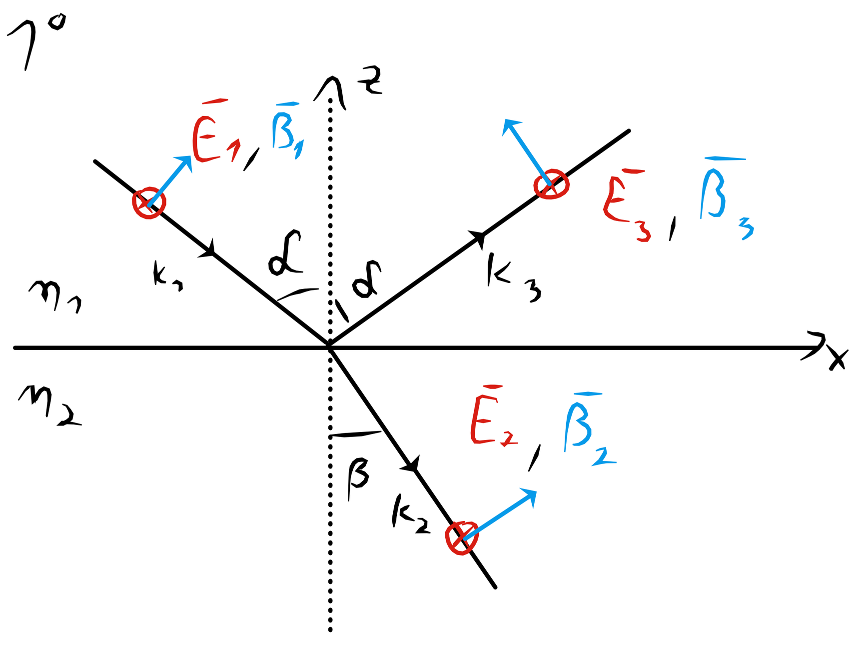
$n_1\sin\alpha=n_2\sin\beta$

$k_1=k_3 \qquad \omega_1=\omega_2=\omega_3$

$$\frac{n_1}{n_2}=\frac{\frac{c}{v_1}}{\frac{c}{v_2}}=\frac{v_2}{v_1}=\frac{\frac{\omega_2}{k_2}}{\frac{\omega_1}{k_1}}=\frac{k_1}{k_2}$$

$$\Rightarrow \frac{n_1}{n_2}=\frac{k_1}{k_2}$$

1°



1) $E_1+E_3=E_2$

2) $0=0$

3) $\frac{1}{\mu_1}k_1E_1\cos\alpha-\frac{1}{\mu_1}k_3E_3\cos\alpha=\frac{1}{\mu_2}k_2E_2\cos\beta$

4) $k_1E_1\sin\alpha+k_3E_3\sin\alpha=k_2E_2\sin\beta$

$\frac{E_3}{E_1}=R \qquad \frac{E_2}{E_1}=T \qquad \mu_1=\mu_2=1$

1) $1+R=T$

3) $1-R=\frac{n_2}{n_1}T\frac{\cos\beta}{\cos\alpha}$

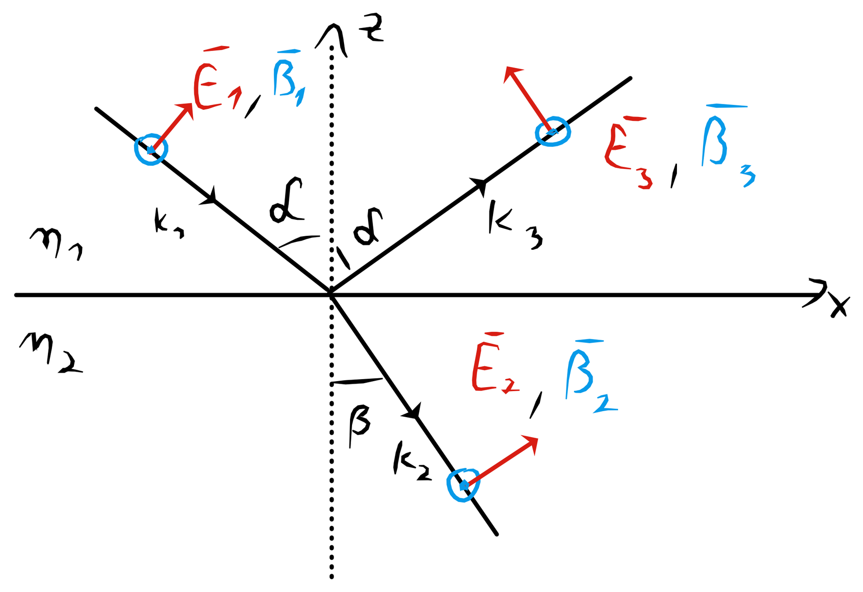
4) $1+R=\frac{n_2}{n_1}T\frac{\sin\beta}{\sin\alpha} \qquad \sin\beta=\frac{n_1}{n_2}\sin\alpha$

$2=T\left(1+\frac{n_2\cos\beta}{n_1\cos\alpha}\right) \qquad \cos\beta=\sqrt{1-\left(\frac{n_1}{n_2}\right)^2\sin^2\alpha}$

$$T=\frac{2n_1\cos\alpha}{n_1\cos\alpha+\sqrt{n_2^2-n_1^2\sin^2\alpha}}$$

$$R=T-1=\frac{n_1\cos\alpha-\sqrt{n_2^2-n_1^2\sin^2\alpha}}{n_1\cos\alpha+\sqrt{n_2^2-n_1^2\sin^2\alpha}}$$

2°



1) $E_1\cos\alpha-E_3\cos\alpha=E_2\cos\beta$

2) $\varepsilon_1E_1\sin\alpha+\varepsilon_1E_3\sin\alpha=\varepsilon_2E_2\sin\beta$

3) $\frac{1}{\mu_1}k_1E_1+\frac{1}{\mu_1}k_3E_3=\frac{1}{\mu_2}k_2E_2$

4) $0=0$

1) $1-R=T\frac{\cos\beta}{\cos\alpha}$

2) $1+R=T\frac{n_2^2\sin\beta}{n_1^2\sin\alpha}$

3) $1+R=T\frac{n_2}{n_1}$

$2=T\left(\frac{n_2}{n_1}+\frac{\cos\beta}{\cos\alpha}\right)$

$$T=\frac{2}{\frac{\sin\alpha}{\sin\beta}+\frac{\cos\beta}{\cos\alpha}}$$

$$R=T\frac{\sin\alpha}{\sin\beta}-1$$

$$R=\frac{\frac{\sin\alpha}{\sin\beta}-\frac{\cos\beta}{\cos\alpha}}{\frac{\sin\alpha}{\sin\beta}+\frac{\cos\beta}{\cos\alpha}}=\frac{\sin(2\alpha)-\sin(2\beta)}{\sin(2\alpha)+\sin(2\beta)}=$$

$$=\frac{\sin(\alpha-\beta)\cos(\alpha+\beta)}{\sin(\alpha+\beta)\cos(\alpha-\beta)}=\frac{\tan(\alpha-\beta)}{\tan(\alpha+\beta)}$$

całkowite wewnętrzne odbicie dla 1°: $\qquad R=0$ dla $\alpha=\beta$ lub $\alpha+\beta=\frac{\pi}{2}$ - kąt Brewstera

granica, gdy $\sin\beta=1 \qquad \sin\alpha=\frac{n_2}{n_1}$, więc odbicie dla $\sin\alpha>\frac{n_2}{n_1}$

$\sqrt{n_2^2-n_1^2\sin^2\alpha}$ - urojone

$$R=\frac{n_1\cos\alpha-i\sqrt{n_1^2\sin^2\alpha-n_2^2}}{n_1\cos\alpha+i\sqrt{n_1^2\sin^2\alpha-n_2^2}}=e^{i\delta} \qquad |R|=1$$

$\bar{E}^+(\bar{r},t)=\bar{E}_1e^{i(\bar{k}_1\bar{r}-\omega t)}+\bar{E}_3e^{i(\bar{k}_3\bar{r}-\omega t)} \qquad \bar{E}_1=E\,\bar{e}_y \qquad E_3=E\,e^{i\delta}\bar{e}_y$

$\bar{k}_1=\frac{\omega n_1}{c}(\sin\alpha\,\bar{e}_x-\cos\alpha\,\bar{e}_z)$

$\bar{E}^+(x,z=0^+,t)=E(1+e^{i\delta})\,e^{i\omega\left(\frac{n_1}{c}x\sin\alpha-t\right)}\bar{e}_y \qquad \bar{k}_3=\frac{\omega n_1}{c}(\sin\alpha\,\bar{e}_x+\cos\alpha\,\bar{e}_z)$

$\bar{E}^+(x,z=0^+,t)=\bar{E}^-(x,z=0^-,t)$

$\bar{E}^-$ spełnia $\frac{c^2}{n_2^2}\Delta E^--\frac{\partial^2E}{\partial t^2}=0$ dla $z<0$

Niech $E(x,z,t)=A(x)B(y)C(t)$

$$\frac{c^2}{n_2^2}\left(\frac{1}{A}\frac{d^2A}{dx^2}+\frac{1}{B}\frac{d^2B}{dz^2}\right)-\frac{1}{C}\frac{d^2C}{dt^2}=0$$

$A(x)B(0)C(t)=E(1+e^{i\delta})\,e^{i\omega\left(\frac{n_1}{c}x\sin\alpha-t\right)}$

$A=e^{i\frac{\omega n_1}{c}x\sin\alpha} \qquad C=e^{-\omega t}$

$$-\frac{c^2}{n_2^2}\left(\frac{\omega n_1}{c}\sin^2\alpha\right)^2-\frac{c^2}{n_2^2}\frac{1}{B}\frac{d^2B}{dz^2}+\omega^2=0$$

$$\frac{d^2B}{dt^2}=\frac{\omega^2}{c^2}(n_2^2-n_1^2\sin^2\alpha)\,B$$

$B=D_1e^{\frac{\omega}{c}\sqrt{\text{dodatnie}}\,z}+D_2e^{-\frac{\omega}{c}\sqrt{\text{dodatnie}}\,z} \qquad D_2=0$, bo wybucha w $z\to-\infty$

$E^-(x,z,t)=E(1+e^{i\delta})\,e^{i\omega\left(\frac{n_1}{c}\sin\alpha-t\right)+\gamma z}$ $\qquad$ zanika wgłąb z