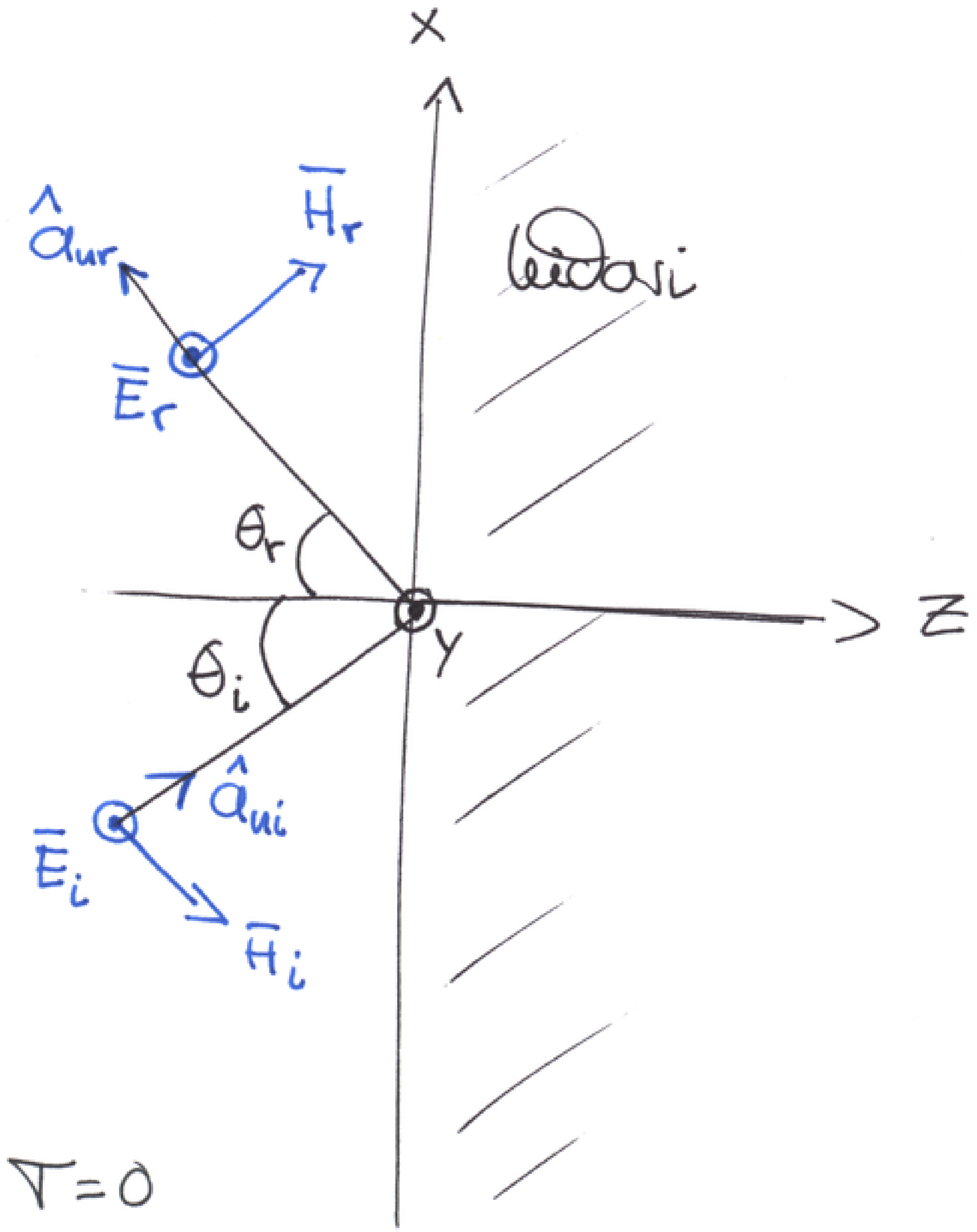
Speglun í leiðandi yfirborði

Endanlegt innfallshorn

Lárétt skautun – E-skautun



Innbylgja með

$$\hat{a}_{ui} = \hat{a}_x \sin\theta_i + \hat{a}_z \cos\theta_i$$

θ_i : Innfallshorn

$$\overline{E}_i(x,z) = \hat{a}_y E_{i0} e^{-i\beta_1 \hat{a}_{ui}\cdot\overline{R}}$$

$$= \hat{a}_y E_{i0} e^{-i\beta_1 (x\sin\theta_i + z\cos\theta_i)}$$

$$\overline{H}_i(x,z) = \frac{1}{\eta_1}\left[\hat{a}_{ui} \times \overline{E}_i(x,z)\right]$$

$$= \frac{E_{i0}}{\eta}\left(-\hat{a}_x\cos\theta_i + \hat{a}_z\sin\theta_i\right) \cdot e^{-i\beta_1(x\sin\theta_i + z\cos\theta_i)}$$

Speglaða bylgjan

$$\hat{a}_{ur} = \hat{a}_x \sin\theta_r - \hat{a}_z \cos\theta_r$$

θ_r: speglunar horn

því er speglaða rafsviðið

$$\bar{E}_r(x,z) = \hat{a}_y E_{ro}\, e^{-i\beta_1(x\sin\theta_r - z\cos\theta_r)}$$

Í yfirborðinu verður heildar-rafsviðið að hverfa

$$\bar{E}_1(x,0) = \bar{E}_i(x,0) + \bar{E}_r(x,0)$$

$$= \hat{a}_y\left(E_{io}\, e^{-i\beta_1 x\sin\theta_i} + E_{ro}\, e^{-i\beta_1 x\sin\theta_r}\right) = 0$$

Gengur aðeins fyrir öll x ef

$$E_{ro} = -E_{io}$$

$$\theta_r = \theta_i$$

Lögmál Snells fyrir spegun

því er speglaða segulsviðið

$$\bar{H}_r(x,z) = \frac{1}{\eta_1}\left[\hat{a}_{ur} \times \bar{E}_r(x,z)\right]$$

$$= \frac{E_{io}}{\eta_1}\left(-\hat{a}_x \cos\theta_i - \hat{a}_z \sin\theta_i\right) \cdot e^{-i\beta_1(x\sin\theta_i - z\cos\theta_i)}$$

Heildarsviðin eru

$$\bar{E}_1(x,z) = \bar{E}_i(x,z) + \bar{E}_r(x,z)$$

$$= -\hat{a}_y E_{io}\, 2i \sin(\beta_1 z \cos\theta_i)\, e^{-i\beta_1 x \sin\theta_i}$$

$$\bar{H}_1(x,z) = -2\frac{E_{io}}{\eta_1}\left[\hat{a}_x \cos\theta_i \cos(\beta_1 z\cos\theta_i) + \hat{a}_z\, i \sin\theta_i \sin(\beta_1 z \cos\theta_i)\right] \cdot e^{-i\beta_1 x \sin\theta_i}$$

* Standbylgja í z-átt
Enginn meðal orku flutningur í z-átt

* Bylgja berst í x-átt samsíða yfirborðinu

$$u_{1x} = \frac{\omega}{\beta_{1x}} = \frac{\omega}{\beta_1 \sin\theta_i} = \frac{u_1}{\sin\theta_i}$$

$$\lambda_{1x} = \frac{\lambda_1}{\sin\theta_i}$$

* Bylgjan í x-ætt er
misbeit slett bylgja þar
sum hon er háð z-hniti

* $\bar{E}_1 = 0$ fyrir øll x tá ið
$\sin(\beta_1 z \cos\theta_i) = 0$

* Víxlmynstur millum inn og út
bylgju
Við støðuvum ikki speglum
tröngsgeisla, heldur flatar
bylgju á „stóran" flöt.

$$\longrightarrow \text{Ef} \quad \beta_1 z \cos\theta_i = \frac{2\pi}{\lambda_1} z \cos\theta_i = -m\pi \,, \quad m = 1, 2, 3, \ldots$$

tí myndi flatur leiðari í $z = \dfrac{m\lambda_1}{2\cos\theta_i}$
engu broyta um bylgjurnar millum
hesara tveggja leiðara

$\hookrightarrow$ er TE þverrafsviðsbylgja
í bylgjuleiðara

$\uparrow E_{1x} = 0$

Vigur Poyntings
liggur bara í
x-ætt.

yfirborðsstraumur

$$H_1(x,0) = -\frac{E_{i0}}{\eta_1}\left(\hat{a}_x 2\cos\theta_i\right) e^{-i\beta_1 x \sin\theta_i}$$

Innan leiðara hverfa $\overline{E}_2$ og $\overline{H}_2$

→ því er stökk í $\overline{H}$ sem tengist yfirborðsstraumi

$$\overline{J}_s(x) = \hat{a}_{n2} \times \overline{H}_1(x,0)$$

$$= (-\hat{a}_z) \times (-\hat{a}_x)\, \frac{E_{i0}}{\eta_1}\left(2\cos\theta_i\right) e^{-i\beta_1 x \sin\theta_i}$$

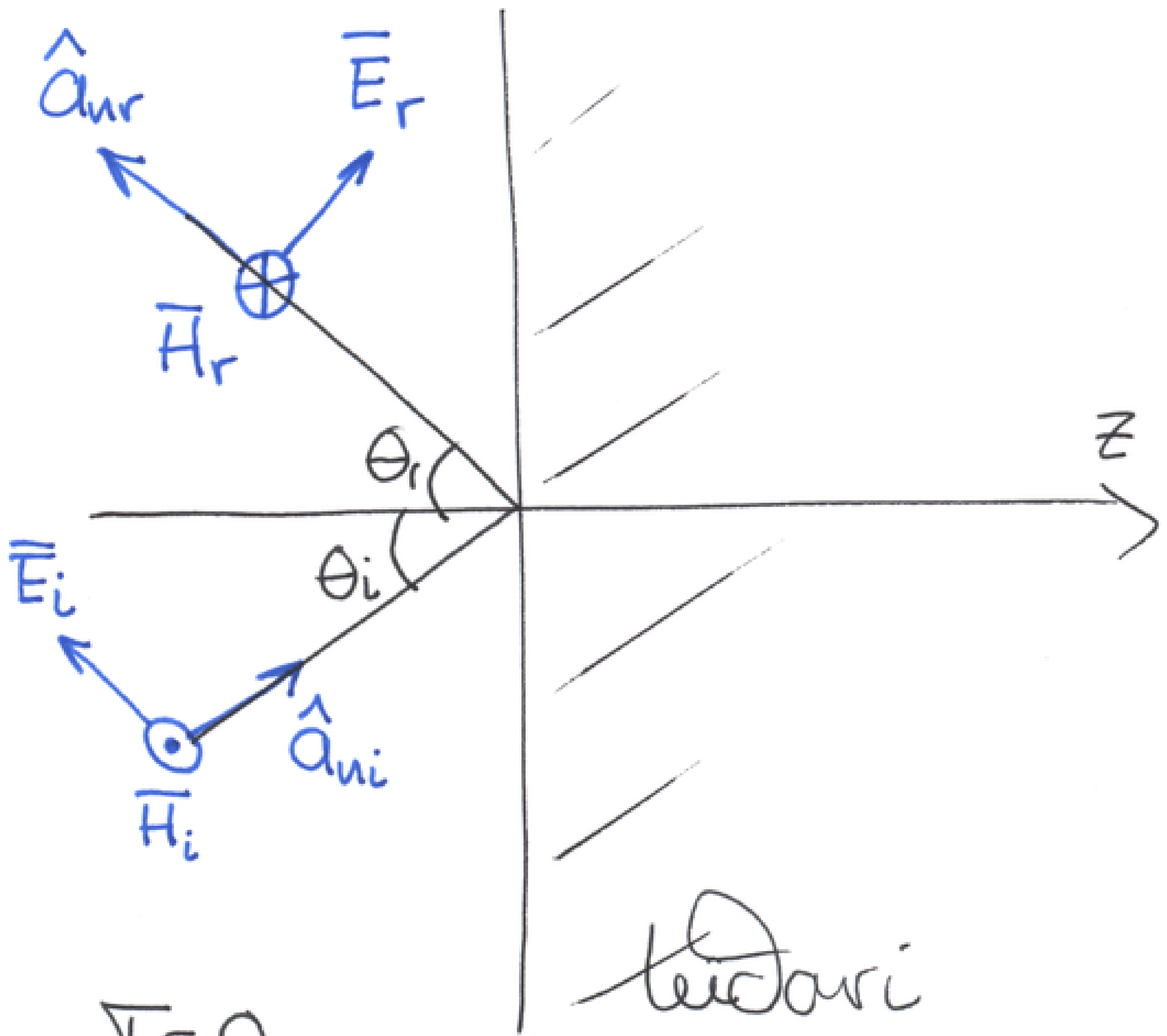
$$= \hat{a}_y\, \frac{E_{i0}}{\eta_1}\left(2\cos\theta_i\right) e^{-i\beta_1 x \sin\theta_i}$$

$$\overline{J}_s(x,t) = \hat{a}_y\, \frac{E_{i0}}{\eta_1}\, 2\cos\theta_i\, \cos\left\{\omega\left(t - \frac{x}{u_1}\sin\theta_i\right)\right\}$$

þessi straumur veldur speglaðu bylgjunni og skeytir út bylgjunni sem hefði farið inn í leiðaram

Samsíða skautan

Hornrætt skautan, H-skautan



$\Gamma = 0$

$$\overline{E}_i(x,z) = E_{i0}(\hat{a}_x \cos\theta_i - \hat{a}_z \sin\theta_i) \cdot e^{-i\beta_1(x\sin\theta_i + z\cos\theta_i)}$$

$$\overline{H}_i(x,z) = \hat{a}_y \frac{E_{i0}}{\eta_1} e^{-i\beta_1(x\sin\theta_i + z\cos\theta_i)}$$

og speglaðu bylgjurnar

$$\overline{E}_r(x,z) = E_{r0}(\hat{a}_x \cos\theta_r + \hat{a}_z \sin\theta_r) e^{-i\beta_1(x\sin\theta_r - z\cos\theta_r)}$$

$$\overline{H}_r(x,z) = -\hat{a}_y \frac{E_{r0}}{\eta_1} e^{-i\beta_1(x\sin\theta_r - z\cos\theta_r)}$$

Í $z=0$ verður partur heildarraf-sviðsins samsíða leiðaranum og hverfa

$$\left(E_{io}\cos\theta_i\right)e^{-i\beta_1 x\sin\theta_i} + \left(E_{ro}\cos\theta_r\right)e^{-i\beta_1 x\sin\theta_r} = 0$$

$$\longrightarrow \quad E_{ro} = -E_{io}\,, \quad \theta_r = \theta_i$$

Heildarsviðið verður

$$\bar{E}_1(x,z) = -2E_{io}\left\{\hat{a}_x\, i\cos\theta_i \sin(\beta_1 z\cos\theta_i) + \hat{a}_z \sin\theta_i \cos(\beta_1 z\cos\theta_i)\right\} \cdot e^{-i\beta_1 x\sin\theta_i}$$

og

$$\bar{H}_1(x,z) = \hat{a}_y\, 2\frac{E_{io}}{\eta_1}\cos(\beta_1 z\cos\theta_i)\, e^{-i\beta_1 x\sin\theta_i}$$

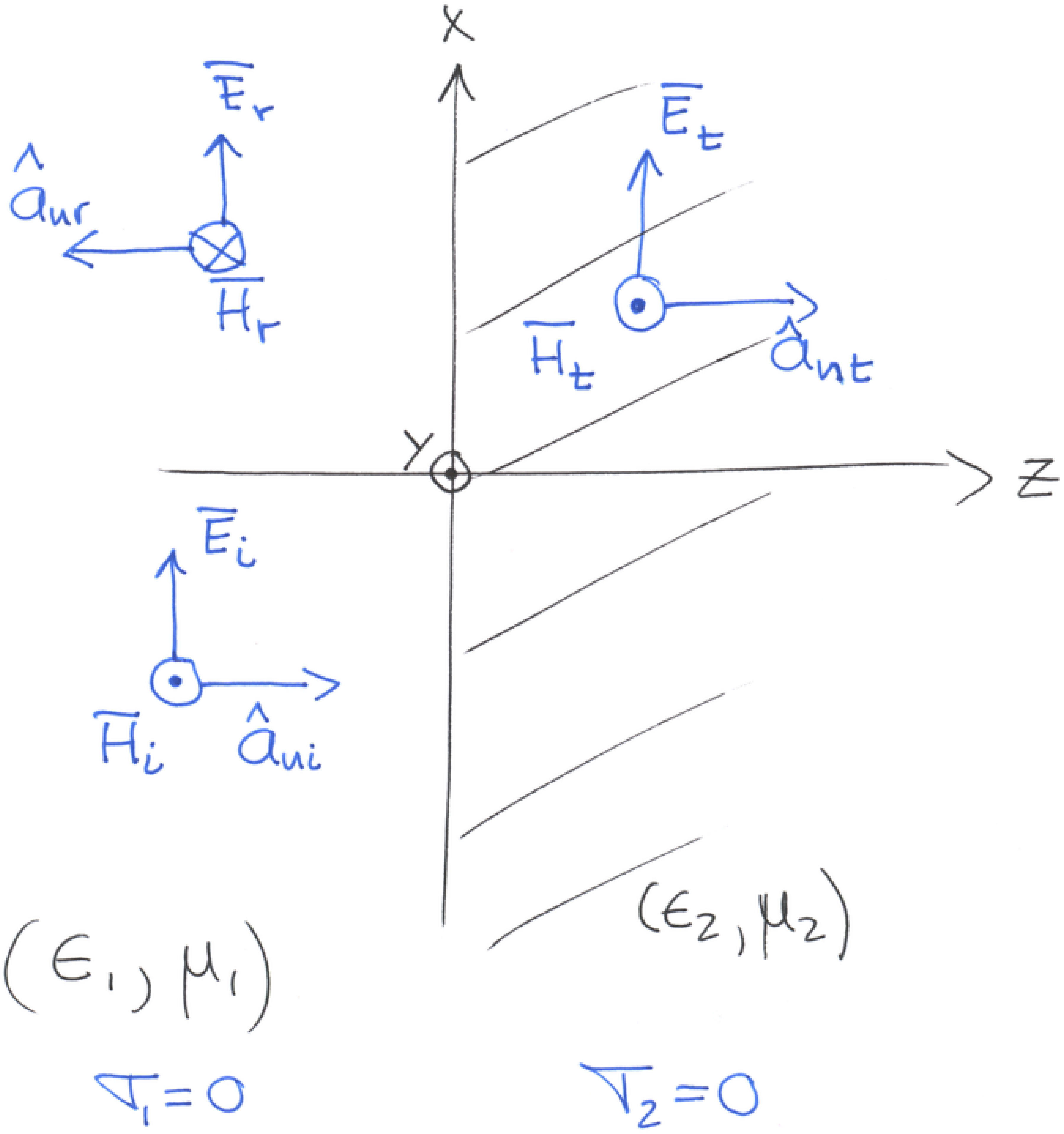
* Aftur misbeint slætt bylgja í x-ætt
* TM - bylgja, $H_{1x} = 0$

Þunnur leiðari í

$$z = -\frac{m\lambda_1}{2\cos\theta_i}\,, \quad m = 1, 2, 3, \ldots$$

broytir einki

Lóðrétt bylgja á skilflöt tveggja rafsvara



Veljum innbylgju

$$\overline{E}_i(z) = \hat{a}_x E_{i0} e^{-i\beta_1 z}$$

$$\overline{H}_i(z) = \hat{a}_y \frac{E_{i0}}{\eta_1} e^{-i\beta_1 z}$$

Speglaða bylgju

$$\overline{E}_r(z) = \hat{a}_x E_{r0} e^{+i\beta_1 z}$$

$$\overline{H}_r(z) = (-\hat{a}_z) \times \frac{1}{\eta_1} \overline{E}_r(z)$$

$$= -\hat{a}_y \frac{E_{r0}}{\eta_1} e^{i\beta_1 z}$$

Framferðarbylgja

$$\overline{E}_t(z) = \hat{a}_x E_{to} e^{-i\beta_2 z}$$

$$\overline{H}_t(z) = \hat{a}_z \times \frac{1}{\eta_2} \overline{E}_t(z)$$

$$= \hat{a}_y \frac{E_{to}}{\eta_2} e^{-i\beta_2 z}$$

Tvær óþekktar stærðir

E_{ro} og E_{to}

$\boxed{\text{Við skilflöt rafsvara verða } \overline{E}_{\parallel} \text{ og } \overline{H}_{\parallel} \text{ að vera samfelld}}$

$$\overline{E}_i(0) + \overline{E}_r(0) = \overline{E}_t(0)$$

$$\longrightarrow E_{io} + E_{ro} = E_{to}$$

$$\overline{H}_i(0) + \overline{H}_r(0) = \overline{H}_t(0)$$

$$\longrightarrow \frac{1}{\eta_1}(E_{io} - E_{ro}) = \frac{E_{to}}{\eta_2}$$

Lausn gefur

$$E_{ro} = \frac{\eta_2 - \eta_1}{\eta_2 + \eta_1} E_{io}$$

$$E_{to} = \frac{2\eta_2}{\eta_2 + \eta_1} E_{io}$$

$$\boxed{\eta_i = \sqrt{\frac{\mu_i}{\epsilon_i}}}$$

Venja er að skilgreina speglunar og framferðar stuðla

$$\boxed{\Gamma = \frac{E_{r0}}{E_{i0}} = \frac{\eta_2 - \eta_1}{\eta_2 + \eta_1} \qquad \tau = \frac{E_{t0}}{E_{i0}} = \frac{2\eta_2}{\eta_2 + \eta_1}}$$

← Hér má sjá mun þegar borið er saman við stammtafræði

Γ getur haft bæði formerki

Í kerfi með tapi verða þessir stuðlar tvinntölur → fasamunur

Greinilega gildir

$$\boxed{1 + \Gamma = \tau}$$

Ef ② væri kjörleiðari $\eta_2 = 0$

fæst $\Gamma = -1$, $\tau = 0$

$E_{r0} = -E_{i0}$, $E_{t0} = 0$