Geislunar mynstur - stikar

Hertz-tvískauts geislun fjærsvið

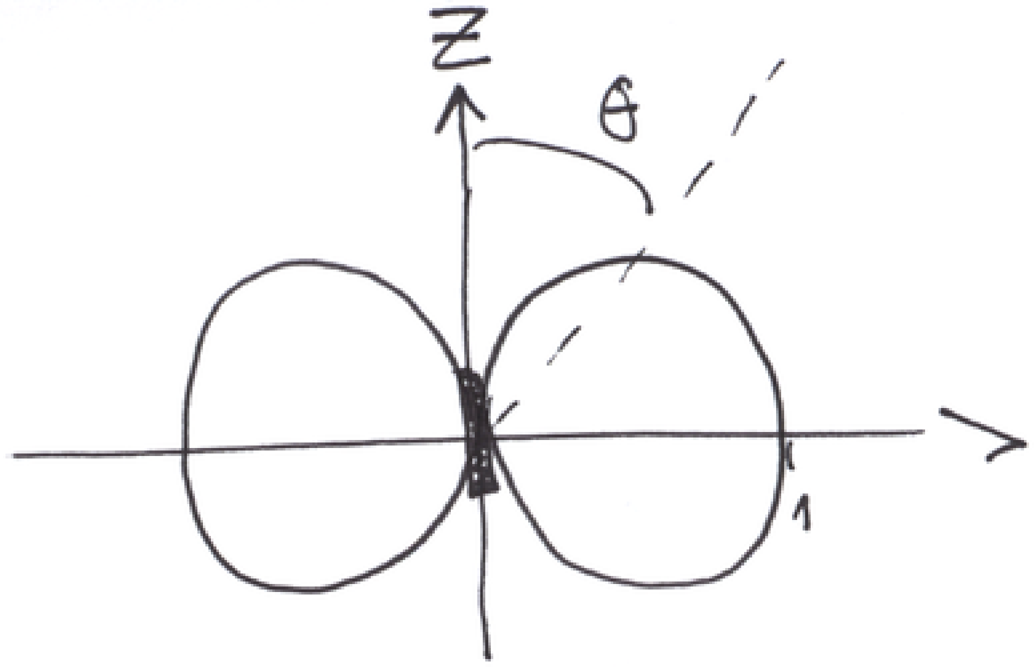
$$E_\theta \sim \eta_0 \frac{e^{-i\beta R}}{R} \sin\theta$$

$$H_\phi \sim \frac{e^{-i\beta R}}{R} \sin\theta$$

$$E_\theta \sim H_\phi \quad , \text{ óháð } \phi$$

(E-plane): gefið R

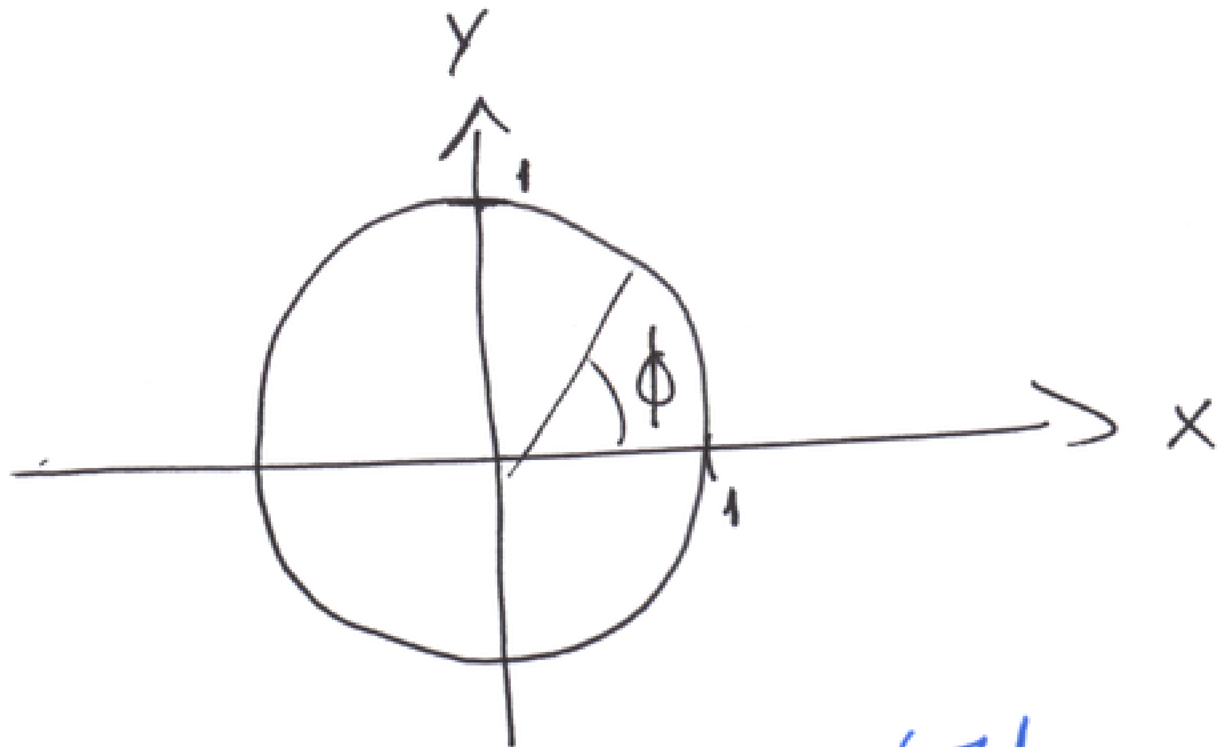
normað $|E_\theta| = |\sin\theta|$



lítil geislun í z-átt samsíða tvískautsvægi $\overline{P}$

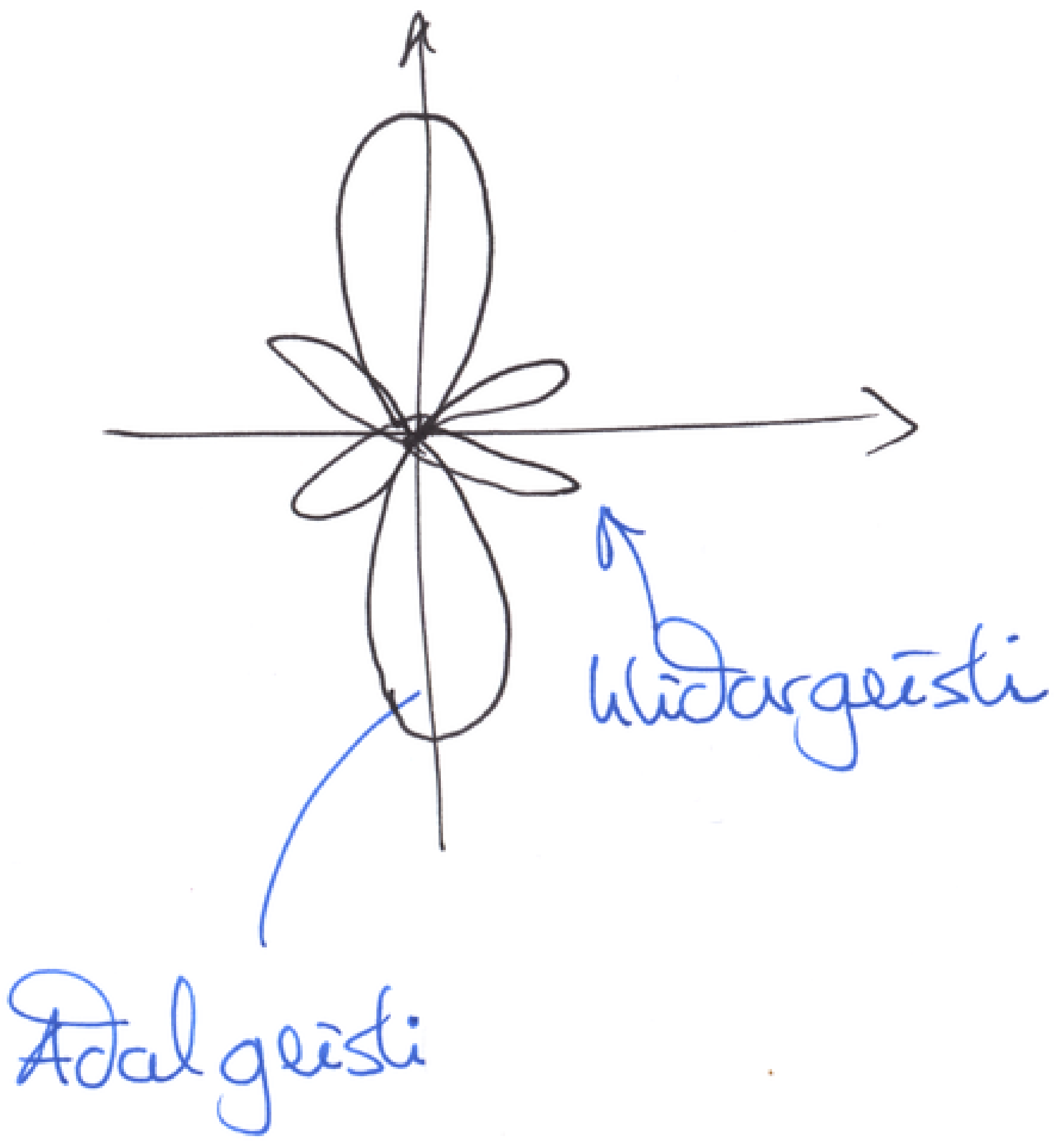
(H-plane): Gefið R, $\theta = \pi/2$

$$E_\theta = |\sin\theta| = 1$$

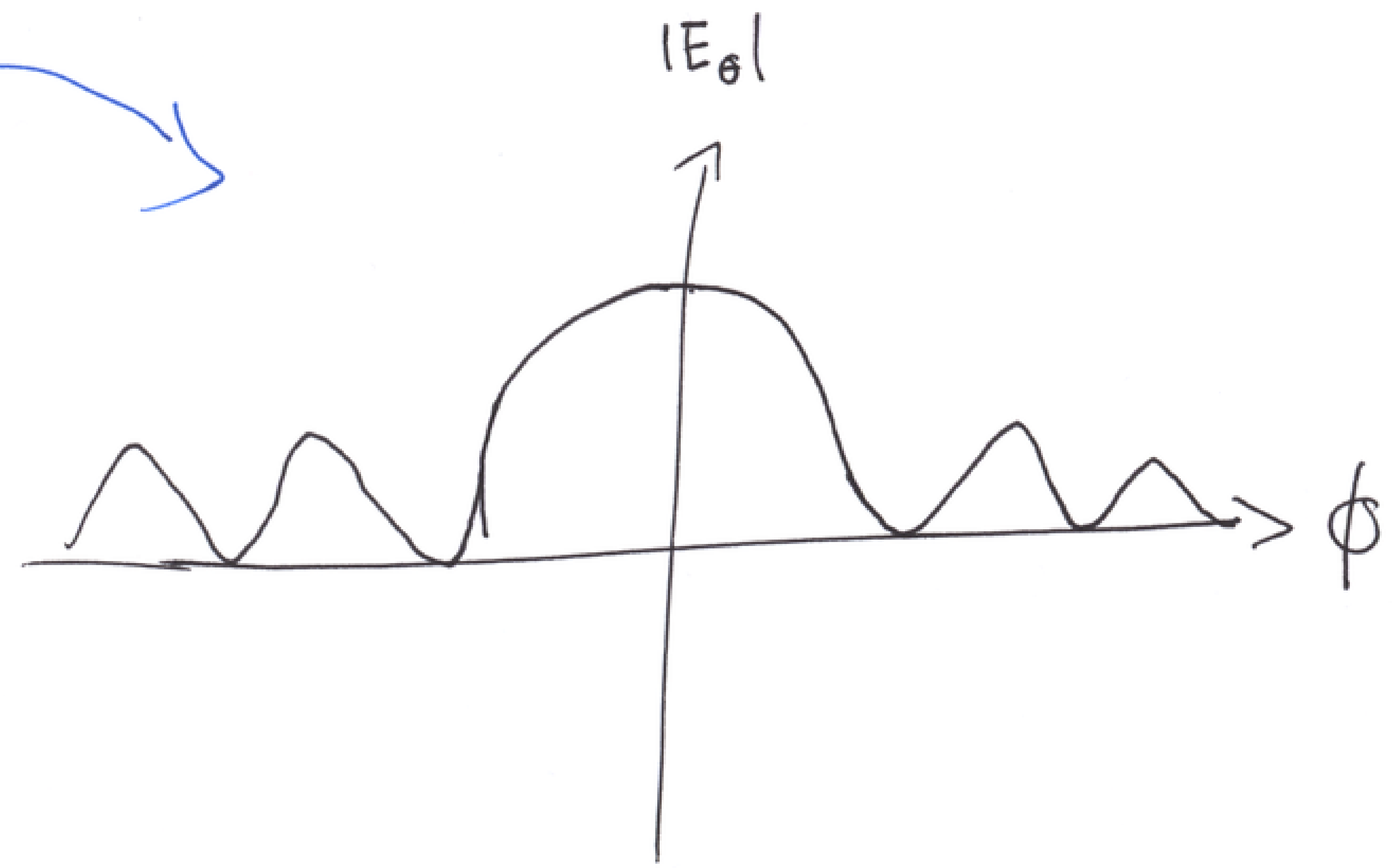


Jöfn geislun í x-y-sléttu

Sum loftnet geta haft mynster i x-y-sléttu



Önnur leið til skoðunar



Þá má skoða geislabreidd og styrk hliðargeisla

Geislunarstyrkur, U

rúmhorn, heil kúla er 4π (sr)

Er mældur í W/sr

$$U = R^2 \mathcal{P}_{ave}$$

og heildarafl geislað

$$P_r = \oint \mathcal{P}_{ave} \cdot d\bar{s} = \oint U \, d\Omega$$

$$(d\Omega = \sin\theta \, d\theta \, d\phi)$$

Stefnumögnun er mæld með

$$\boxed{G_D(\theta,\phi) = 4\pi \frac{U(\theta,\phi)}{P_r}}$$

$$= \frac{4\pi U(\Omega)}{\oint U \, d\Omega}$$

Max stefnumögnunin er áttun (directivity)

$$\boxed{D = \frac{4\pi U_{max}}{P_r}}$$

sem má skrifa sem

$$D = \frac{4\pi |E_{max}|^2}{\int |E(\Omega)|^2 d\Omega}$$

Geislaða aflið

Í loftnetinu og umhverfinu (jörðinni) verður alltaf ónýtt afltap P_e

Heildar inn-aflið er því $P_i = P_r + P_e$

og aflmögnun loftnets er

$$\boxed{G_P = \frac{4\pi U_{max}}{P_i}}$$

Geislunarnýtni er skilgreind

$$\boxed{\eta_r = \frac{G_P}{D} = \frac{P_r}{P_i}}$$

Geislunarviðnám er gildi þess ónýta viðnáms sem eyðir jafnmiklu afli í hita og loftnetið í geislun P_r

⇓

hátt geislunarviðnám er hagkvæmt

Kömmum possa stika með dæmi

Hertz-tvístaut

$$H_\phi = i\frac{I\,dl}{4\pi}\left(\frac{e^{-i\beta R}}{R}\right)\beta \sin\theta$$

$$E_\theta = i\frac{I\,dl}{4\pi}\left(\frac{e^{-i\beta R}}{R}\right)\eta_0\beta \sin\theta$$

$$\mathcal{P}_{ave} = \frac{1}{2}\mathcal{R}e\,|\bar{E}\times\bar{H}^*| = \frac{1}{2}|E_\theta||H_\phi|$$

$$U = R^2\mathcal{P}_{ave} = \frac{(I\,dl)^2}{32\pi^2}\eta_0\beta^2\sin^2\theta$$

$$P_r = \oint U(\Omega)\,d\Omega = 2\pi\int_0^\pi U(\theta)\sin\theta\,d\theta$$

$$P_r = 2\pi\frac{(I\,dl)^2}{32\pi^2}\eta_0\beta^2\underbrace{\int_0^\pi \sin^3\theta\cdot d\theta}$$

$$\left(\frac{1}{3}\cos^3\theta - \cos\theta\right)\Big|_0^\pi$$

$$= -\frac{1}{3}+1$$

$$-\frac{1}{3}+1 = \frac{4}{3}$$

$$P_r = \frac{(I\,dl)^2}{12\pi}\eta_0\beta^2$$

$$G_D(\Omega) = \frac{U(\Omega)\,4\pi}{P_r}$$

$$= \frac{(I\,dl)^2\eta_0\beta^2\sin^2\theta \;\; 12\pi}{8\pi\;\;(I\,dl)^2\eta_0\beta^2}$$

$$= \frac{3}{2}\sin^2\theta$$

$$G_D(\Omega) = \frac{3}{2}\sin^2\theta$$

Mest geislun í x-y-slettu og engin í pólátturnar tvær $\pm \hat{z}$

$$D = G_D(\tfrac{\pi}{2}, \phi) = 1.5$$

$$P_r = \frac{(I\,dl)^2}{12\pi}\eta_0\beta^2$$

notum (8-14) með

$$\eta_0 \simeq 120\pi$$

$$\beta = \frac{2\pi}{\lambda}$$

$$P_r = \frac{I^2}{2}\left\{80\pi^2\left(\frac{dl}{\lambda}\right)^2\right\}$$

til þess að finna geislunar-viðnám notum við

$$P_r = \frac{1}{2}I^2 R_r$$

$$\rightarrow \boxed{R_r = 80\pi\left(\frac{dl}{\lambda}\right)^2}$$

Hér þarf að muna að svipuð okkar er aðeins rétt reiknuð fyrir $dl \ll \lambda$

$\downarrow$

fáum lágt gildi fyrir R_r

Skoðum vírbút með leiðni σ
geisla a, lengd d sem Hertz-tvístaut

Ómskt tap $\quad P_\ell = \frac{1}{2} I^2 R_\ell$

R_ℓ verður að tengja við yfirborðsviðnám R_s

$$R_\ell = R_s \left(\frac{d}{2\pi a} \right) \quad \text{þ.s.} \quad R_s = \sqrt{\frac{\pi f \mu_0}{\sigma}}$$

frá flutningslínunum sem við kölum sleppt

$$\eta_r = \frac{P_r}{P_r + P_\ell} = \frac{R_r}{R_r + R_\ell} = \frac{1}{1 + \left(\frac{R_\ell}{R_r} \right)}$$

$$\rightarrow \eta_r = \frac{1}{1 + \frac{R_s}{160\pi^3} \left(\frac{\lambda}{a} \right) \left(\frac{\lambda}{d} \right)}$$

Ef nú $a = 1{,}8\,\text{mm}$, $d = 2\,\text{m}$, $f = 1.5\,\text{MHz}$

$\sigma = 5.8 \cdot 10^{7}\ \text{S/m}$ fyrir kopar fæst $\lambda = 200\,\text{m}$

og $\eta_r = 0.58 \rightarrow$ 58 % nýtni

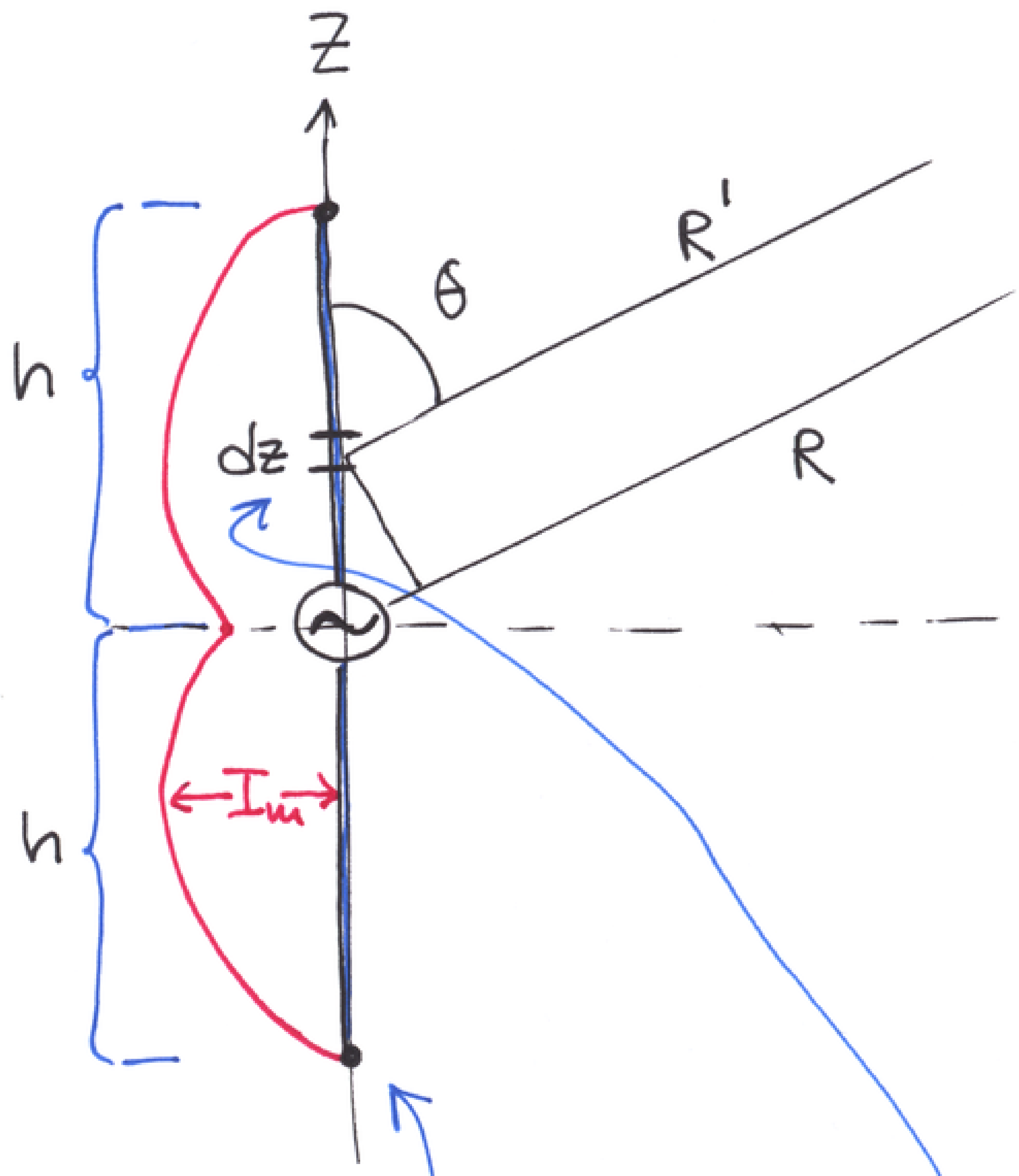
Jafnan

$$\eta_r = \frac{1}{1 + \frac{R_s}{160\pi^3}\left(\frac{\lambda}{a}\right)\left(\frac{\lambda}{d}\right)}$$

sýnir að lág gildi fyrir $\left(\frac{a}{\lambda}\right)$ og $\left(\frac{d}{\lambda}\right)$ lækka nýtnina (En jöfnurnar gilda að eins í þessu markgildi)

Því þurfum við að skoða loftnet með lengd sambærilega við bylgjulengdina λ

Grönn lína



Strauminn verður að hverfa í endunum

sleppum því að ákvarða strauminn sjálfsamkvæmt og gerum ráð fyrir

$$I(z) = I_m \sin\{\beta(h-|z|)\}$$

$$= \begin{cases} I_m \sin\{\beta(h-z)\} & z>0 \\ I_m \sin\{\beta(h+z)\} & z<0 \end{cases}$$

Við látum okkur nægja að kanna fjær-sviðin

$$dE_\theta = \eta_0 \, dH_\phi = i \frac{I dz}{4\pi}\left(\frac{e^{-i\beta R'}}{R'}\right)\eta_0 \beta \sin\theta$$

fyrir litla bút loftnetsins dz

Mjög fjarri loftnetinu $R >> h$

$$R' = \left(R^2 + z^2 - 2Rz\cos\theta\right)^{1/2} \simeq R - z\cos\theta \,, \quad \frac{1}{R} \sim \frac{1}{R'}$$

$$E_\theta = \eta_0 H_\phi = i\,\frac{I_m \eta_0 \beta \sin\theta}{4\pi R}\, e^{-i\beta R} \int_{-h}^{h} \sin\{\beta(h-|z|)\}\, e^{i\beta z\cos\theta}\, dz$$

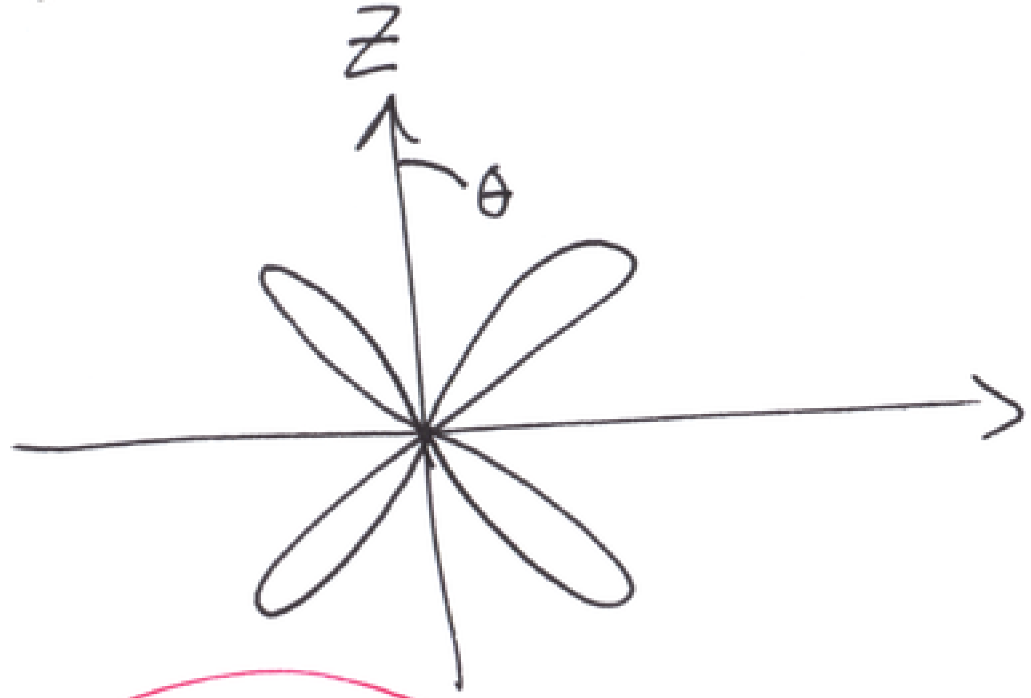
$$= i\,\frac{60 I_m}{R}\, e^{-i\beta R}\, F(\theta)$$

með

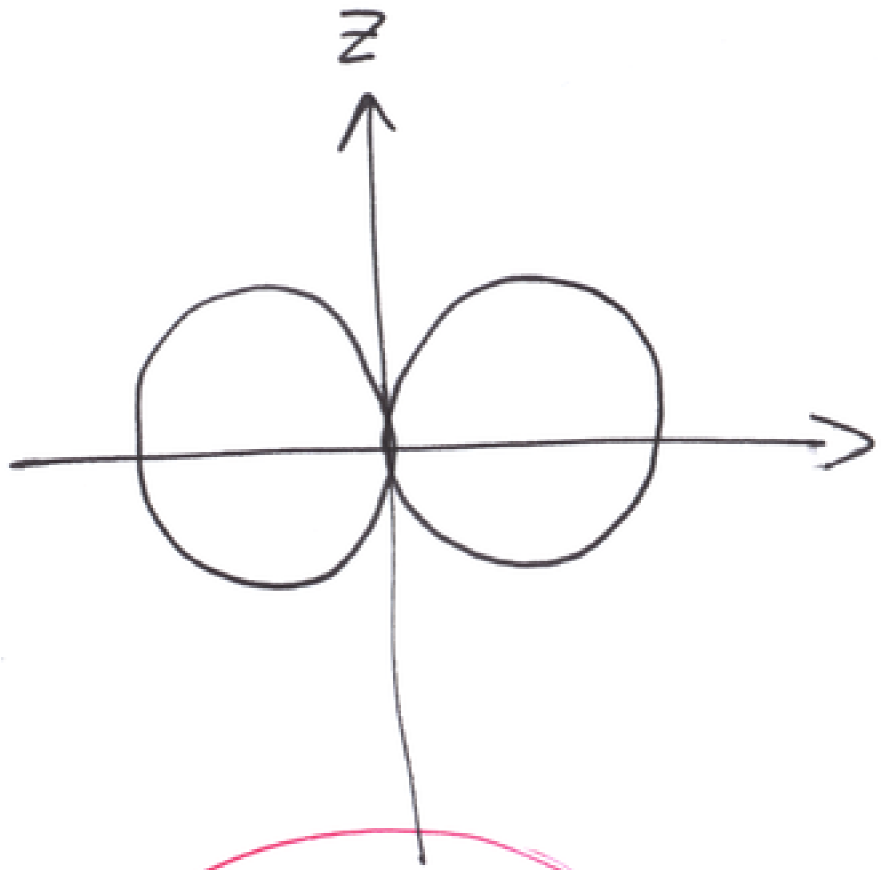
$$F(\theta) = \frac{\cos\{\beta h\cos\theta\} - \cos(\beta h)}{\sin\theta}$$

lengd loftnetsins skiptir öllu máli hér

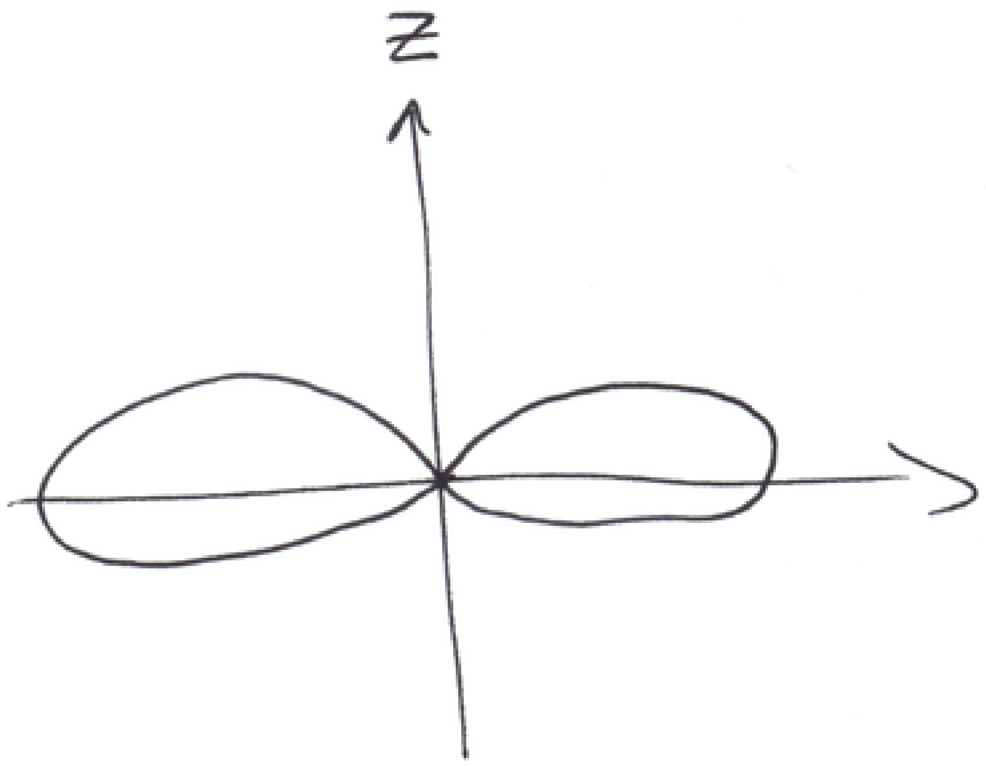
E-plane mynsturfallið fyrir þetta loftnet fyrir $2h = 2\lambda$ er engin geislun í $\pi/2$



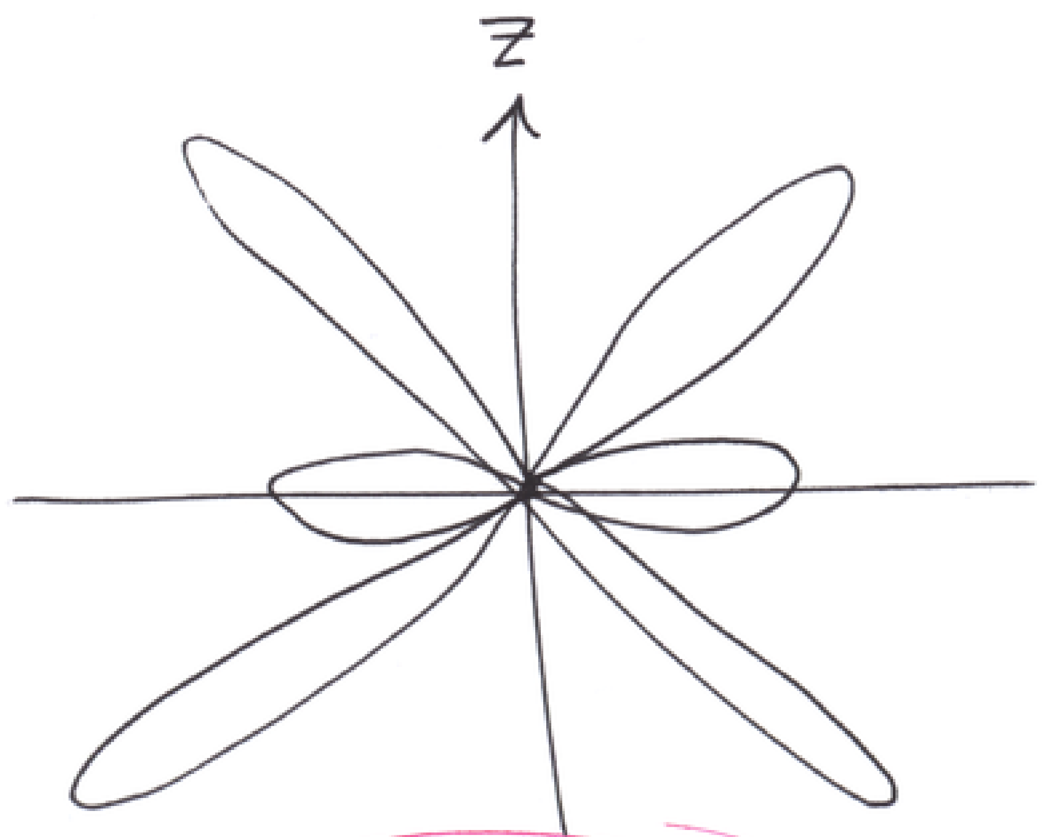
$2h = 2\lambda$



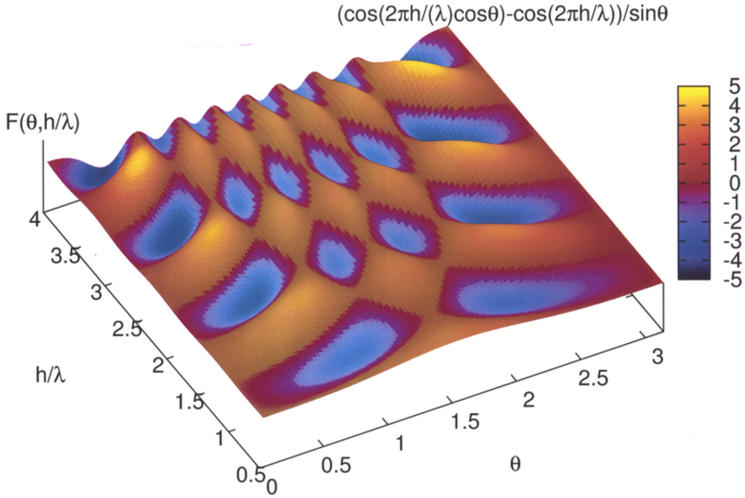
$2h = \frac{1}{2}\lambda$

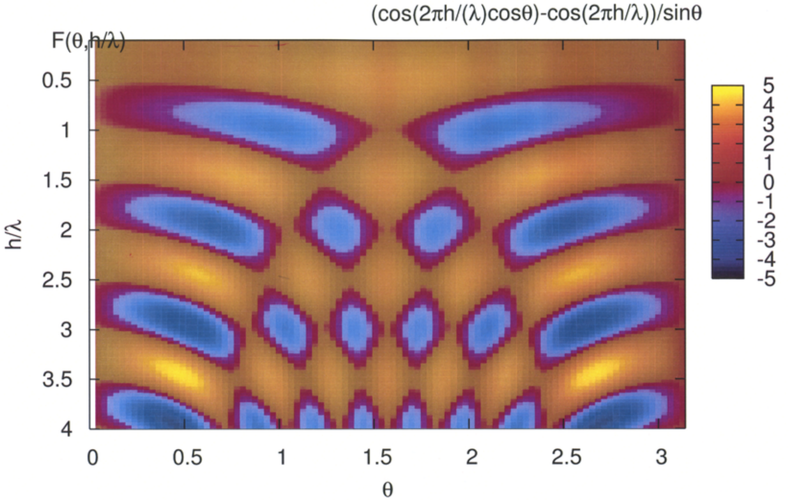


$2h = \lambda$

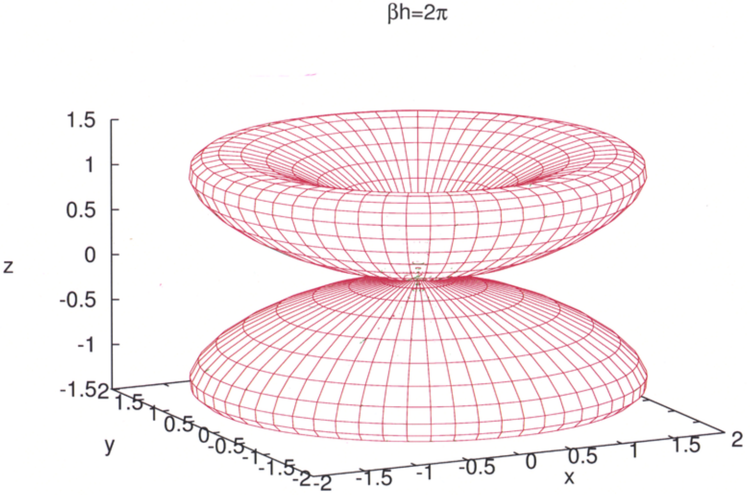


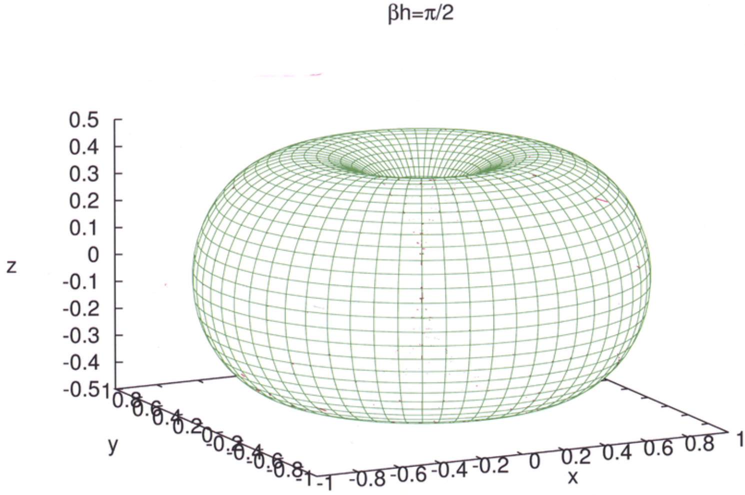
$2h = \frac{3}{2}\lambda$

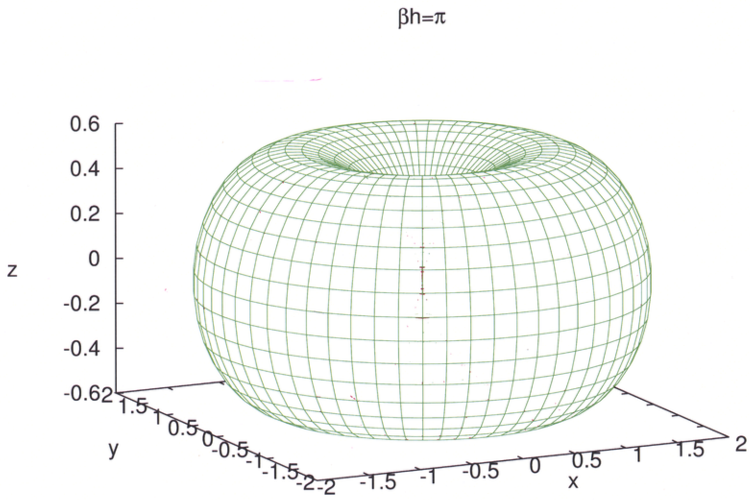

(cos(2πh/(λ)cosθ)-cos(2πh/λ))/sinθ
F(θ,h/λ)
h/λ
θ
4
3.5
3
2.5
2
1.5
1
0.5
0
0.5
1
1.5
2
2.5
3
5
4
3
2
1
0
-1
-2
-3
-4
-5

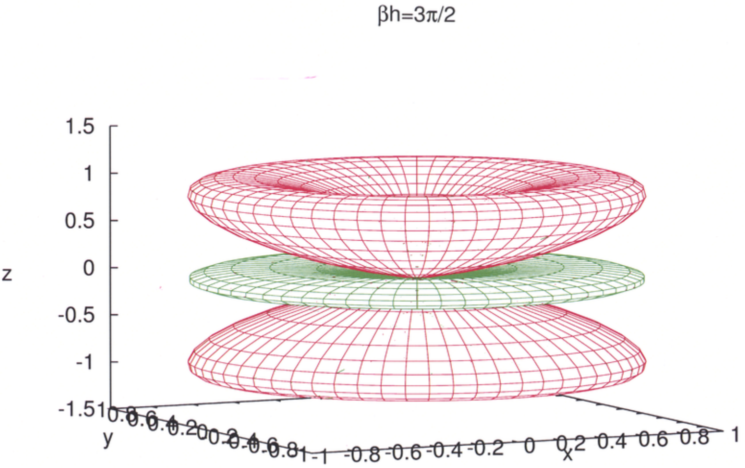


(cos(2πh/(λ)cosθ)-cos(2πh/λ))/sinθ
F(θ,h/λ)
h/λ
θ
0.5
1
1.5
2
2.5
3
3.5
4
0
0.5
1
1.5
2
2.5
3
5
4
3
2
1
0
-1
-2
-3
-4
-5


βh=2π
z
y
x
1.5
1
0.5
0
-0.5
-1
-1.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2


βh=π/2
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
z
y
-1 -0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8 1
x


βh=π
0.6
0.4
0.2
0
-0.2
-0.4
-0.62
z
1.5
1
0.5
0
-0.5
-1
-1.5
-2
y
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
x


βh=3π/2
1.5
1
0.5
0
-0.5
-1
-1.5
z
y
x
-1 -0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8 1