Fizika 2i

Elektromágneses hullámok (EMH) II.

10. előadás

EMH polarizációja I.

$$E_x(z,t) = E_{0x}\cos(\omega t - kz)$$

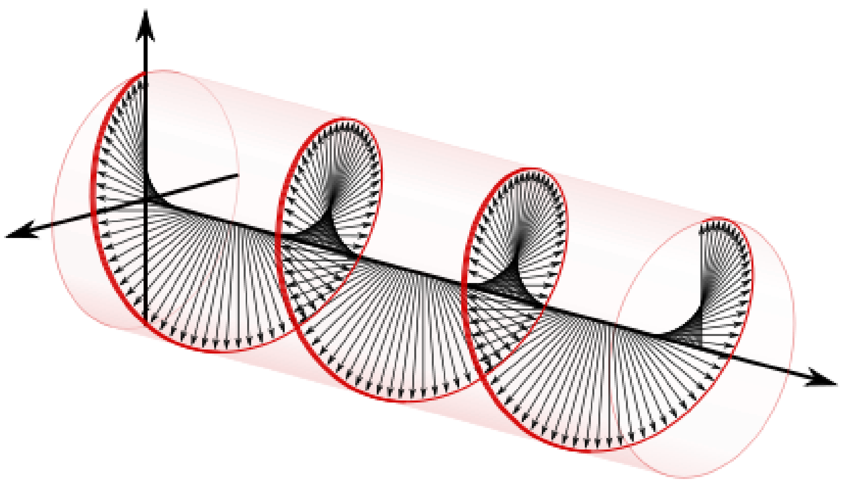
$$E_y(z,t) = E_{0y}\cos(\omega t - kz)$$

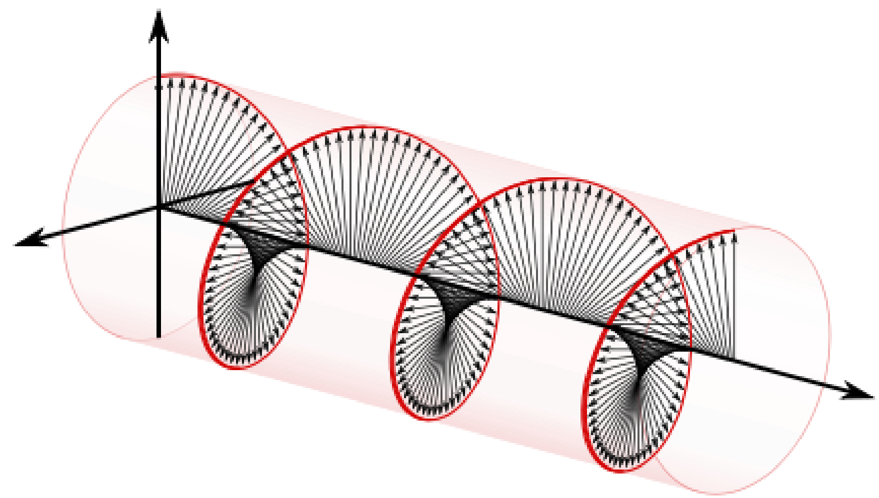
Lineárisan polarizált hullám

***Δφ* = 0**

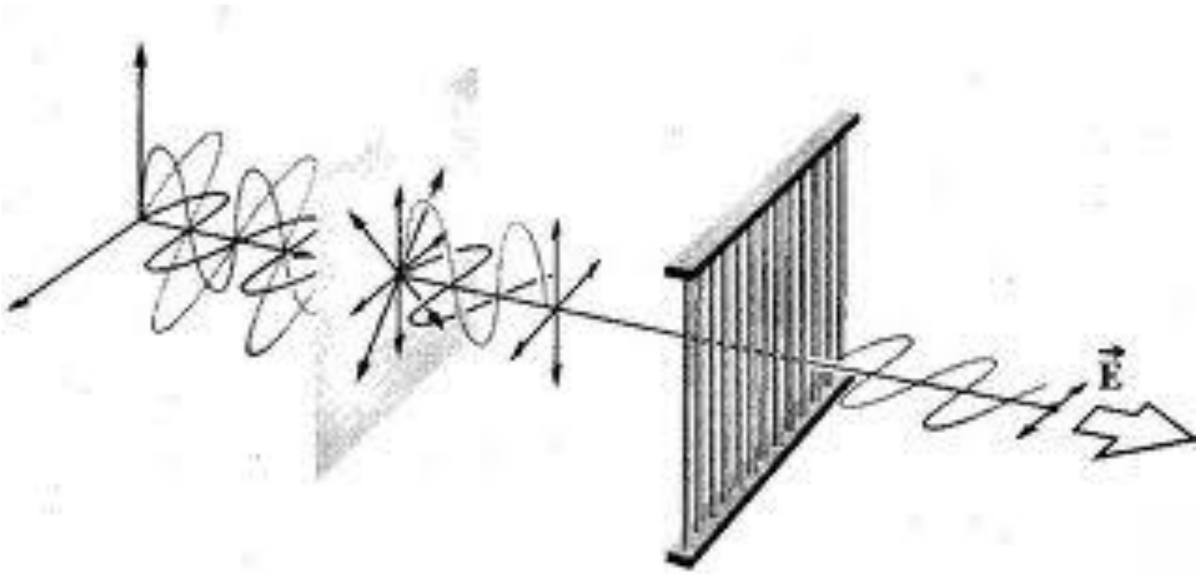
Cirkulárisan polarizált hullám

***Δφ* = 90°**



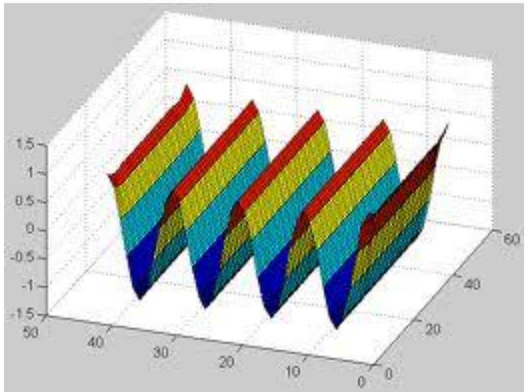


EMH polarizációja II.

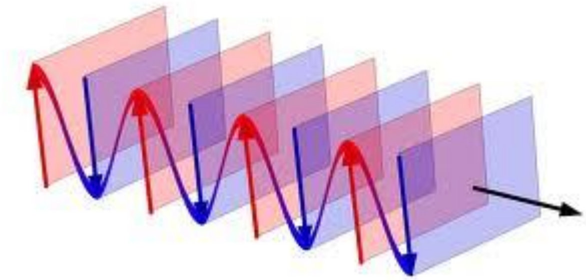


Hertz kísérleti szűrője:

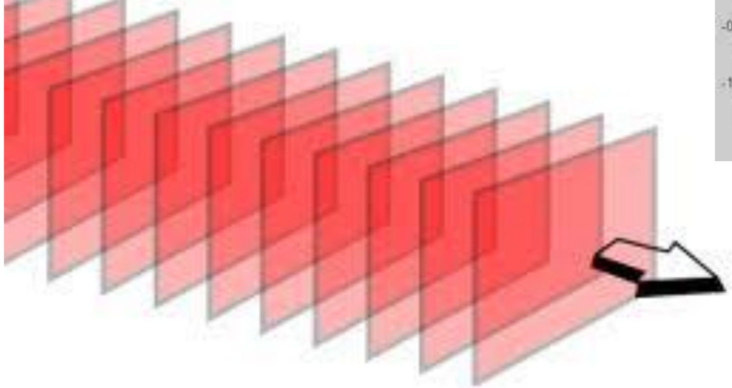
Síkhullám, gömbhullám



Síkhullám:

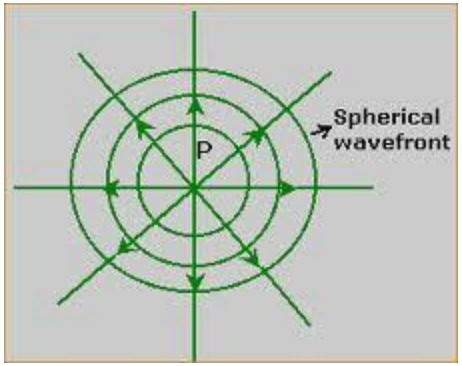


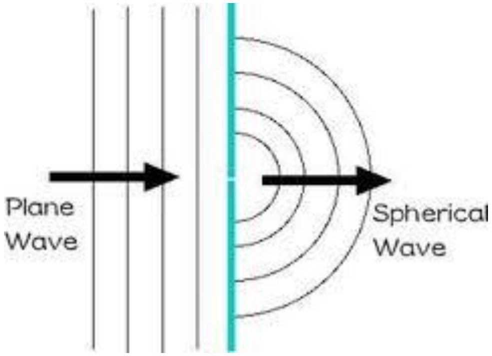
hullámfront



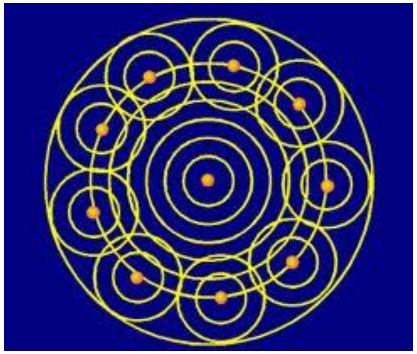
$$E_x(z,t) = E_0 \cos(\omega t \pm kz) \qquad B_y(z,t) = B_0 \cos(\omega t \pm kz)$$

Gömbhullám: $$E(z,t) = \frac{E_0}{r}\cos(\omega t \pm \vec{k}\vec{r}) \qquad B(z,t) = \frac{B_0}{r}\cos(\omega t \pm \vec{k}\vec{r})$$



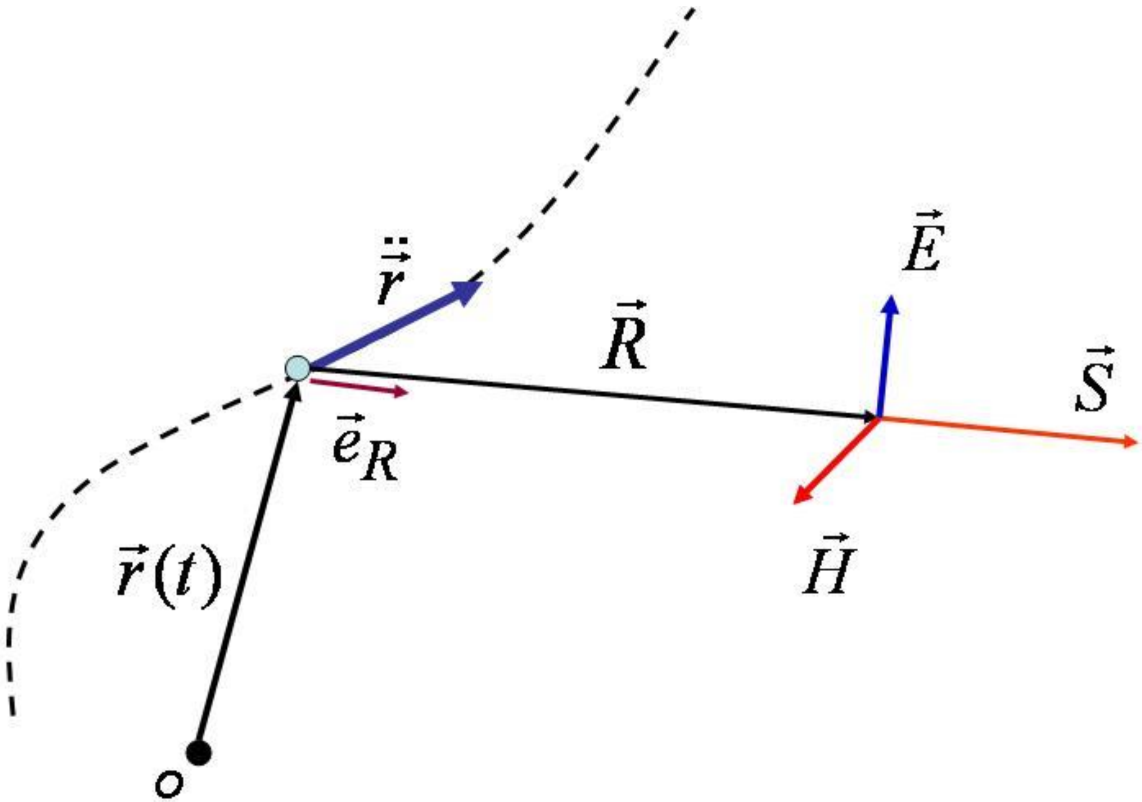


Huygens elv



Töltött részecske sugárzása

Egy gyorsuló részecske elektromos és mágneses tere távoltérben
(***R* >> *d***, ahol ***d*** az emh forrásának jellemző mérete)



$$\vec{H} \sim \frac{q}{R} \ddot{\vec{r}} \times \vec{e}_R$$

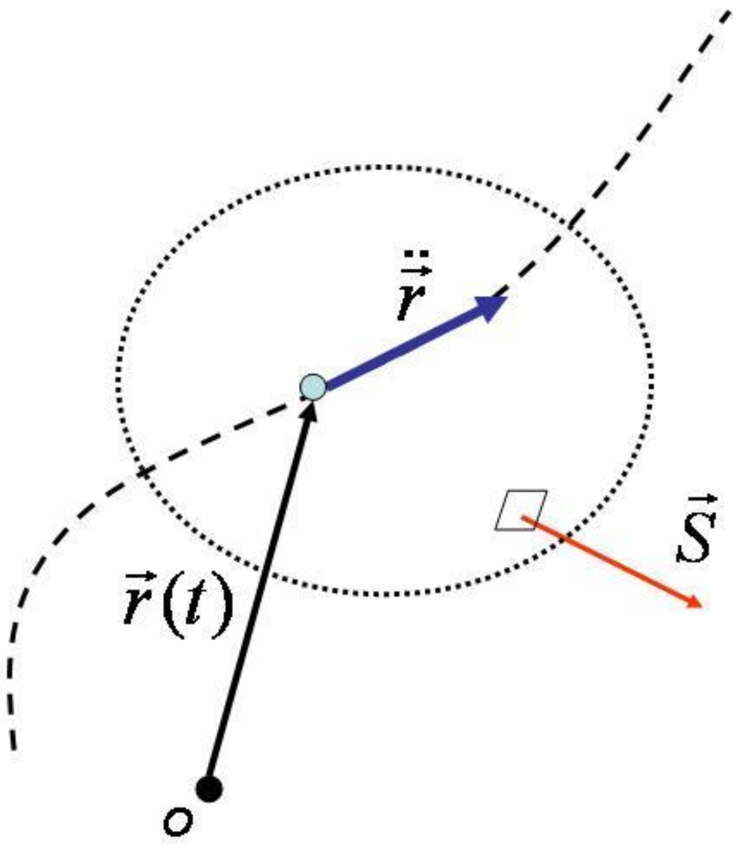
$$\vec{E} \sim \frac{q}{R} \left(\ddot{\vec{r}} \times \vec{e}_R \right) \times \vec{e}_R$$

$$\vec{S} = \vec{E} \times \vec{H}$$

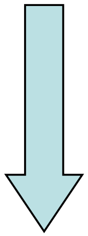
$$\left| \vec{S} \right| \sim \left(\ddot{\vec{r}} \right)^2$$

$$\left| \vec{S} \right| \sim \frac{1}{r^2}$$

Sugárzási teljesítmény



$$P_{sug} = \oint_A \vec{S}d\vec{A}$$

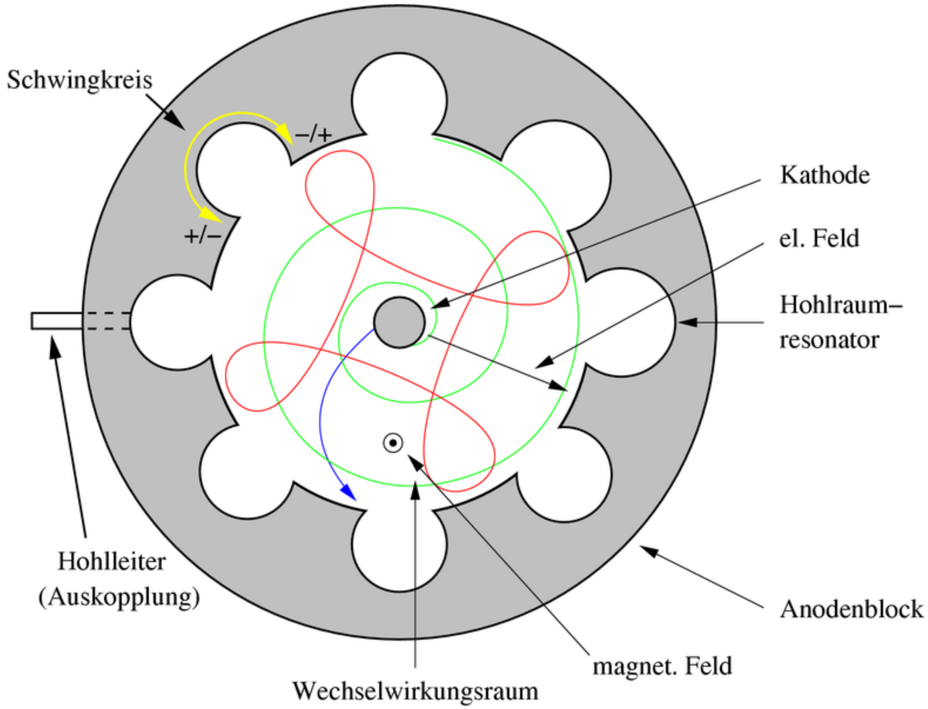


$$P_{\mathrm{sug}} \sim \left(\ddot{\vec{r}}\right)^2$$

EMH keltése I.

Töltött részecskék gyorsítása: részecskegyorsító → igen drága

Másik lehetőség: magnetron



Mikrohullámú sütőben:

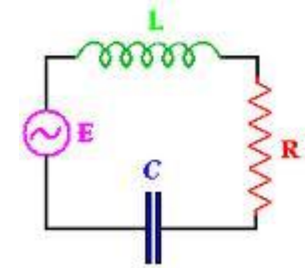
Radarban:

Légi irányítás
Tolató radar

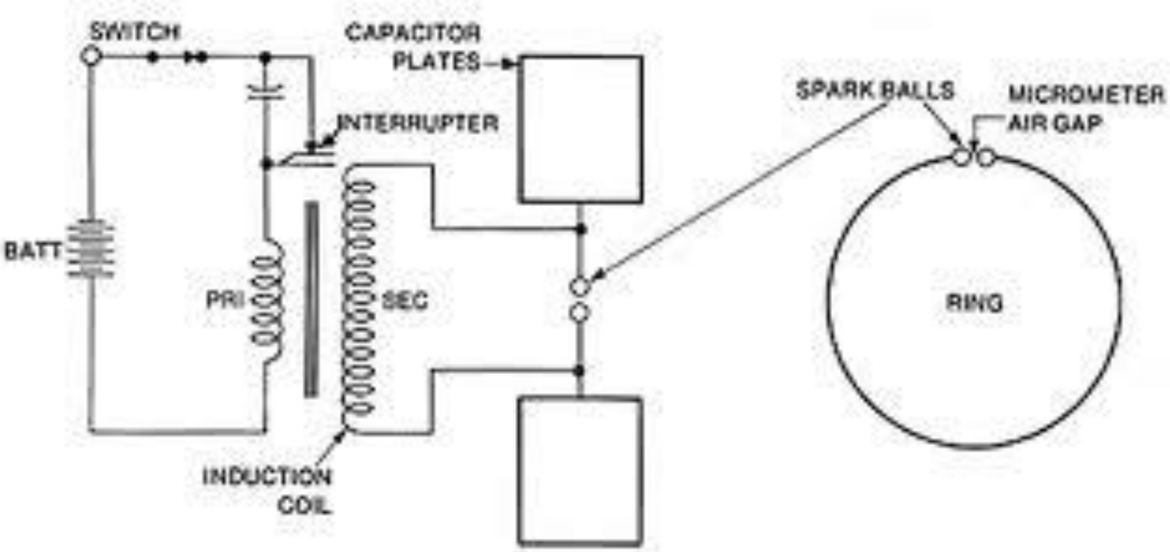
EMH keltése II.

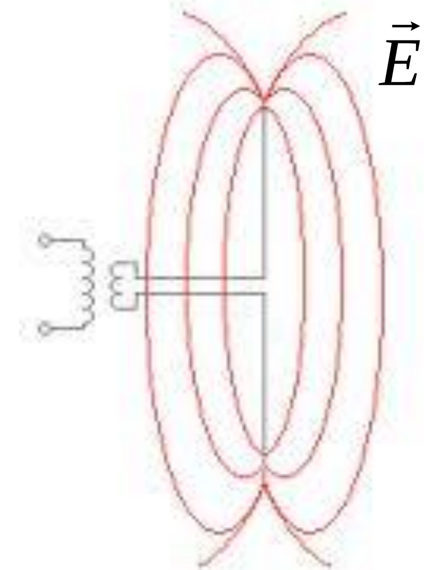
R ≈ 0

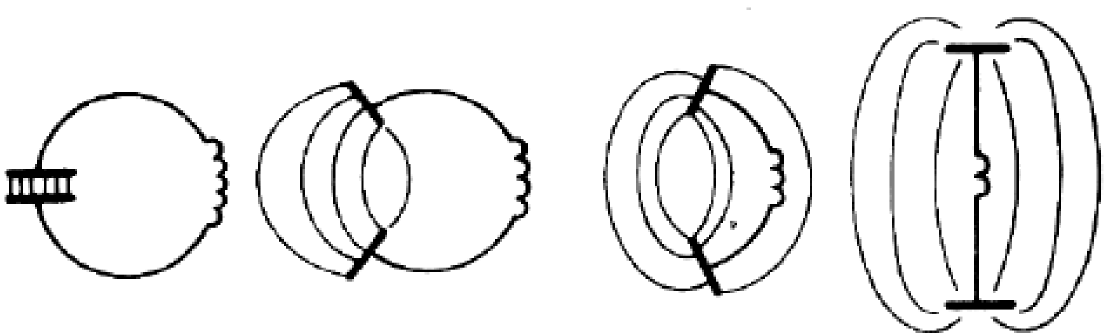
$$\omega_o = \frac{1}{\sqrt{LC}}$$



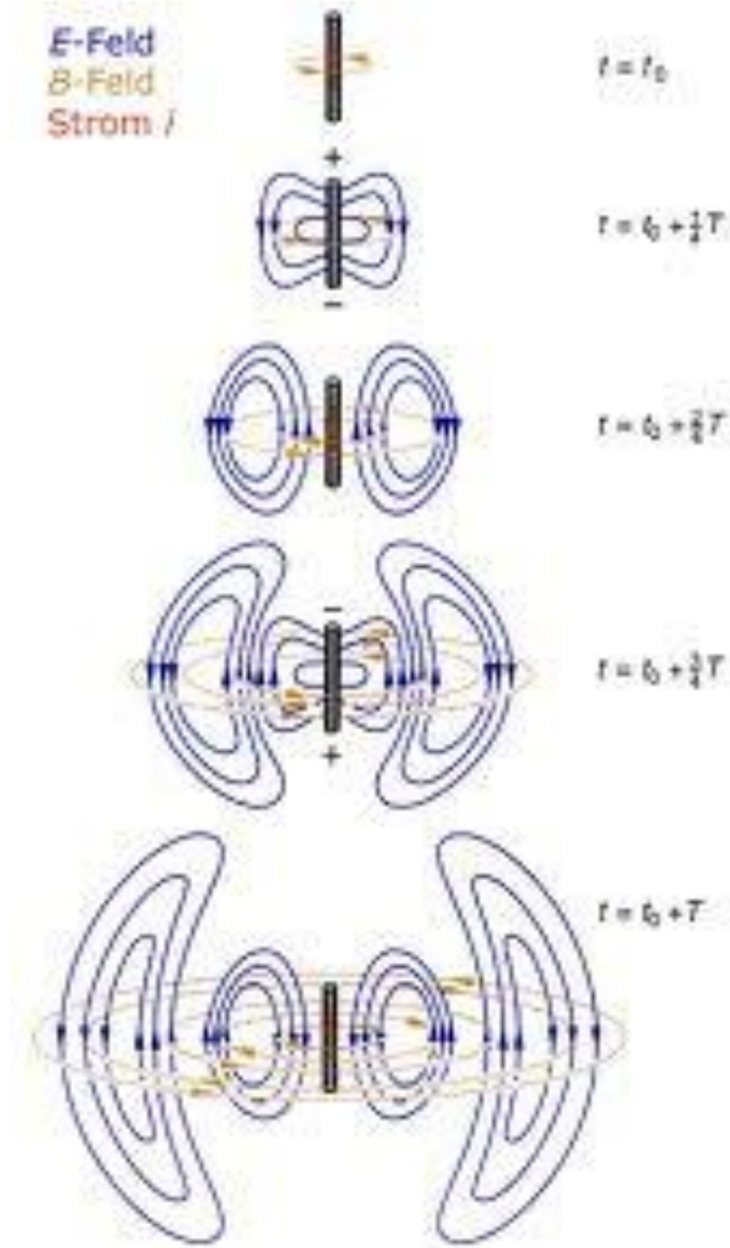
A Hertz féle kísérlet:







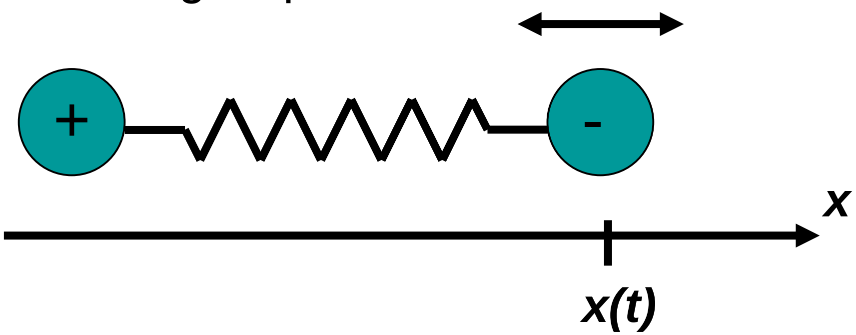
EMH keltése III.



Láttuk: $$\vec{H} \sim \frac{q}{R}\ddot{\vec{r}} \times \vec{e}_R$$

$$\vec{E} \sim \frac{q}{R}\left(\ddot{\vec{r}} \times \vec{e}_R\right) \times \vec{e}_R$$

Rezgő dipól:



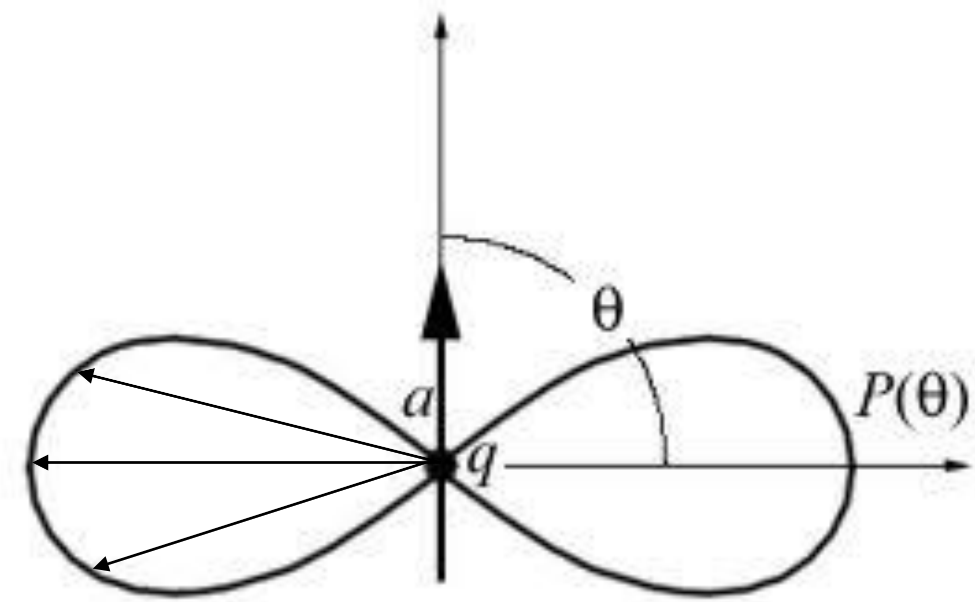
$$p(t) = qx(t) = qA\sin(\omega t)$$

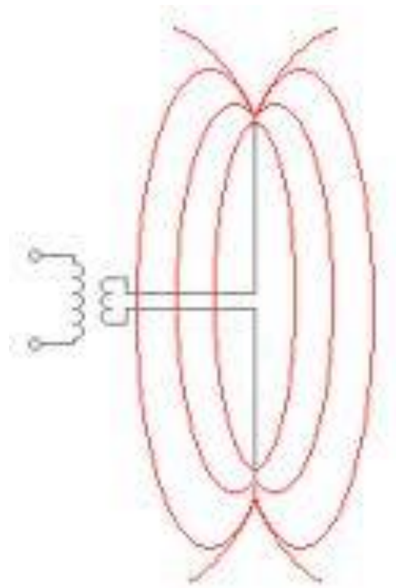
$$I(t) = I_0 \sin(\omega t) \rightarrow q(t) = q_0 \sin(\omega t) \rightarrow p(t) = p_0 \sin(\omega t)$$

Rezgő dipól sugárzási karakterisztikája

$$\vec{H} \sim \frac{q}{R}\ddot{\vec{r}} \times \vec{e}_R$$

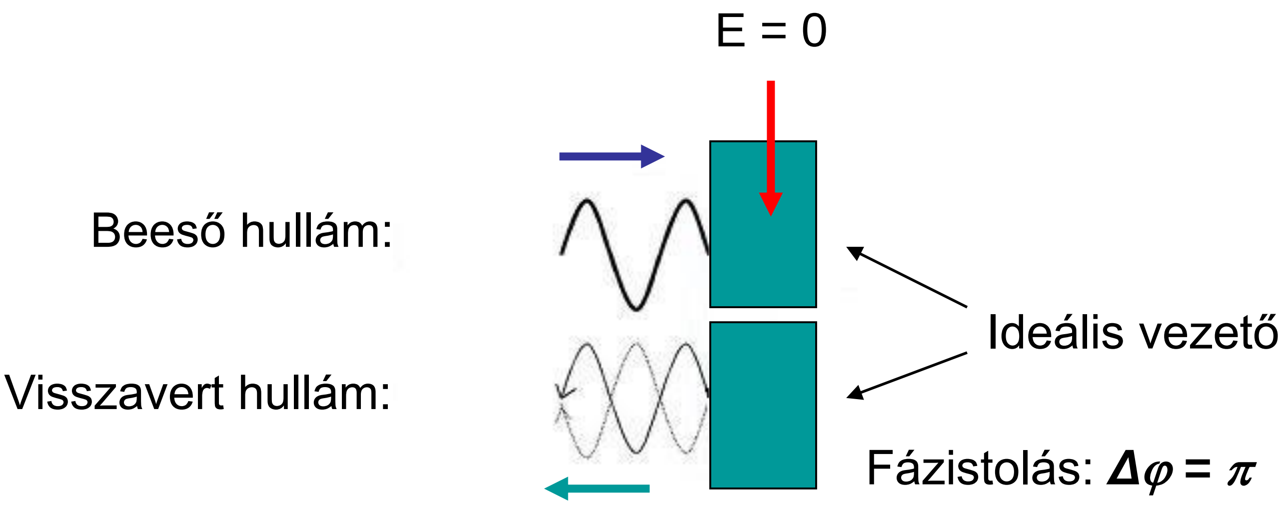
$$\vec{E} \sim \frac{q}{R}\left(\ddot{\vec{r}} \times \vec{e}_R\right) \times \vec{e}_R$$





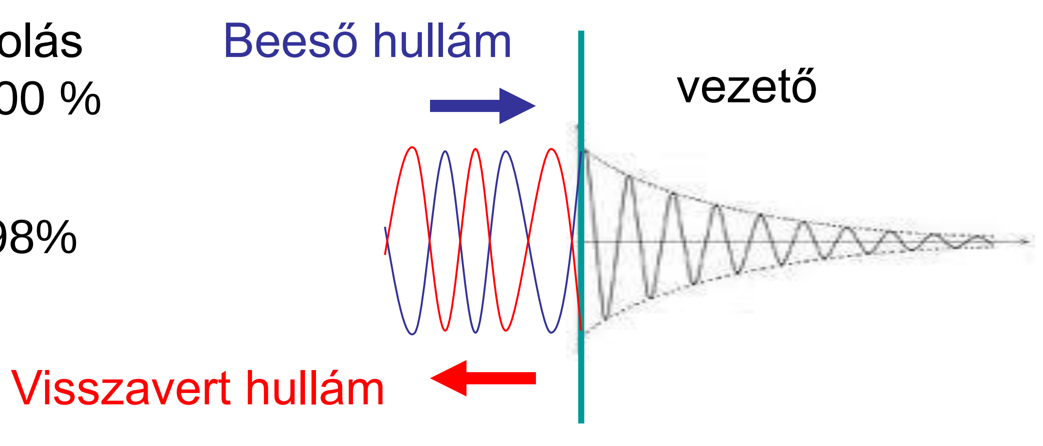
Reflexió, transzmisszió, abszorpció I.

Ideális vezető: $\sigma = \infty$ (nincs ohmikus veszteség)

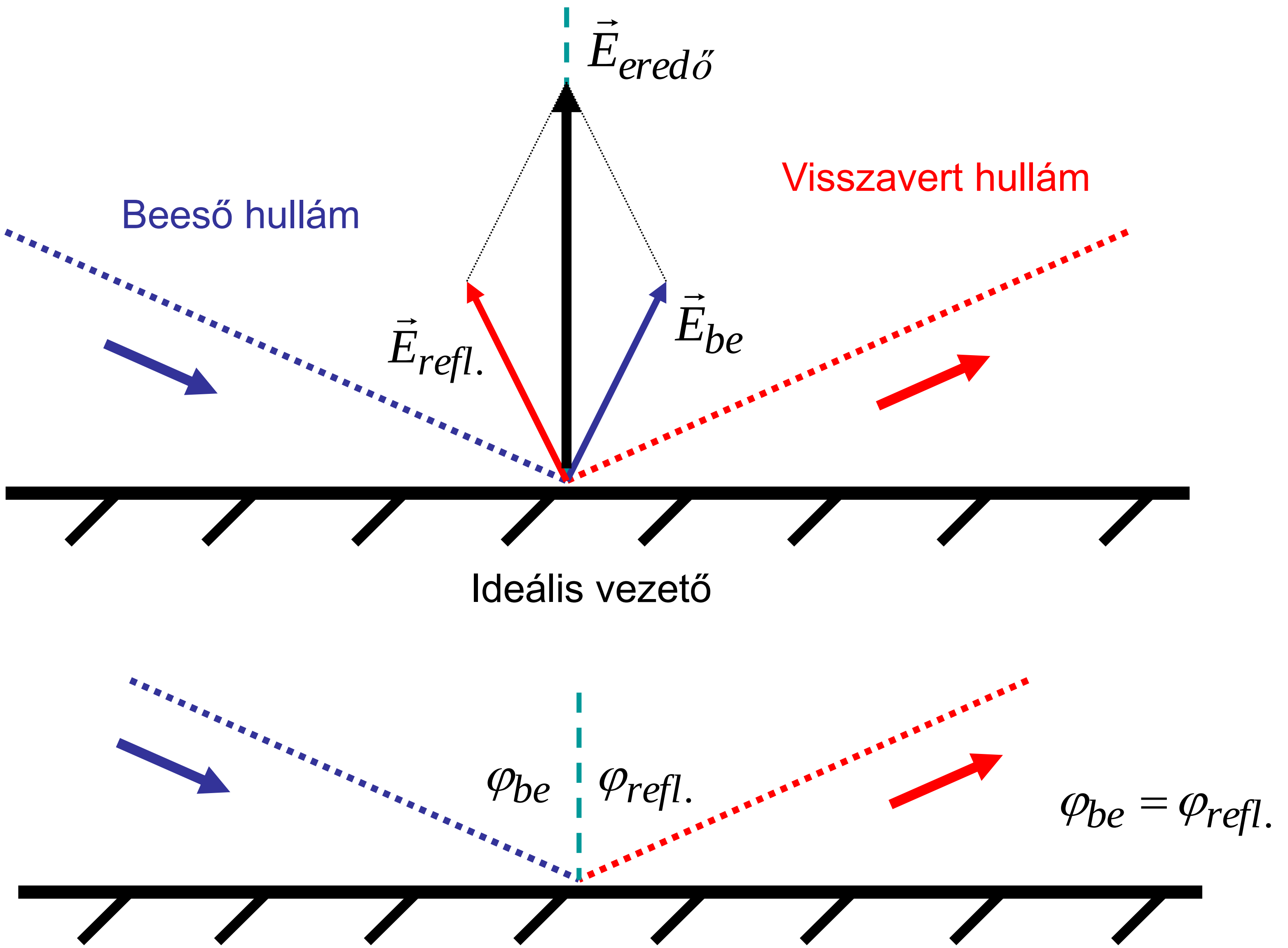


Reális vezető (fém): behatolás
R < 100 %

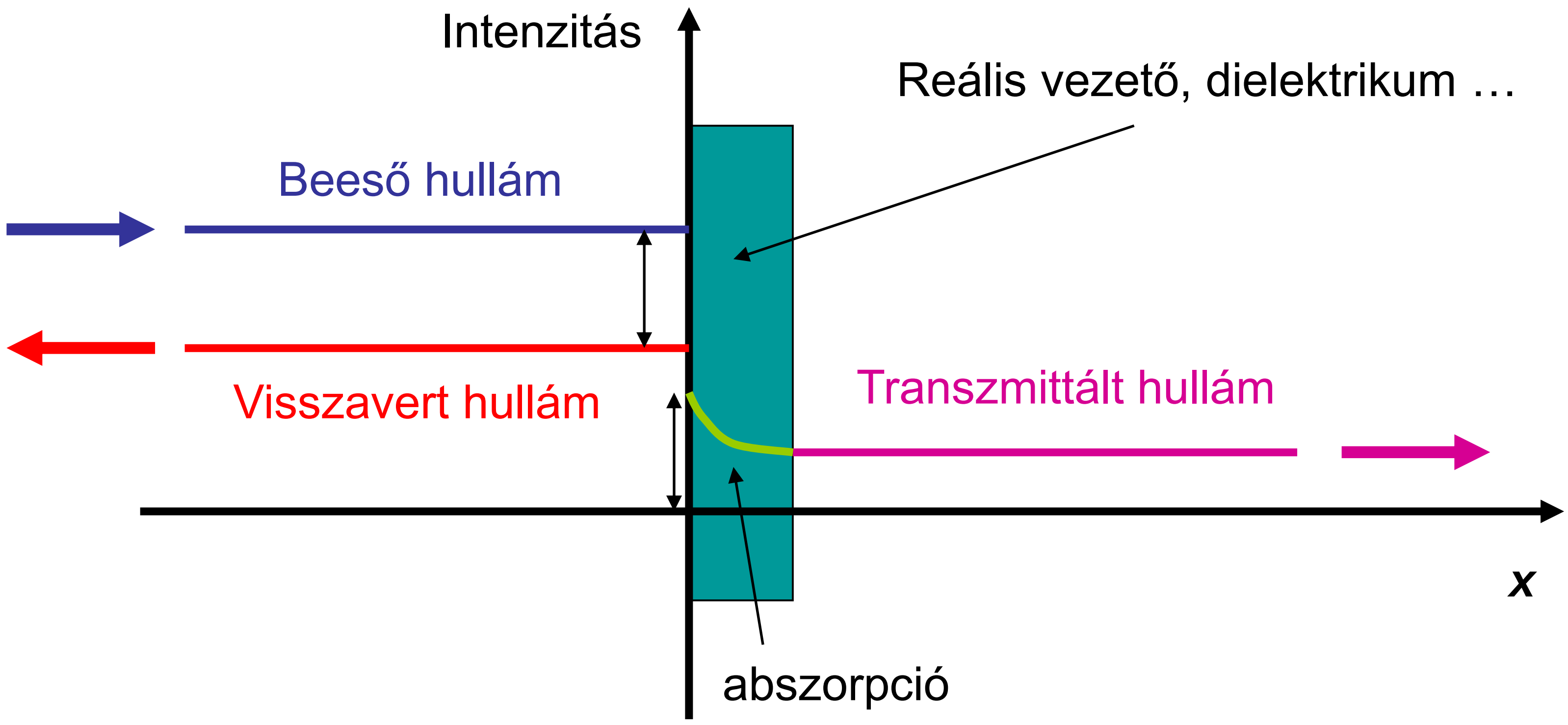
alumínium tükörre R ≈ 98%



Reflexió, transzmisszió, abszorpció II.



Reflexió, transzmisszió, abszorpció III.



$$I_{be} = I_{refl.} + I_{absz.} + I_{tr.}$$

$R = R(\omega)$ és $\sigma = \sigma(\omega)$

Reflexió, transzmisszió, abszorpció IV.

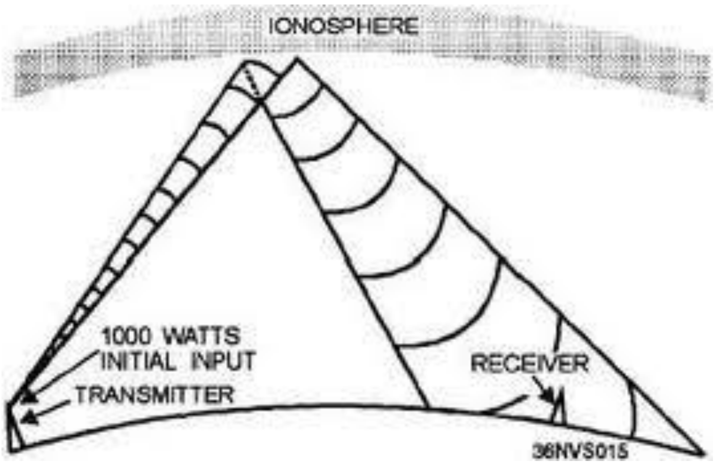
Parabola antenna

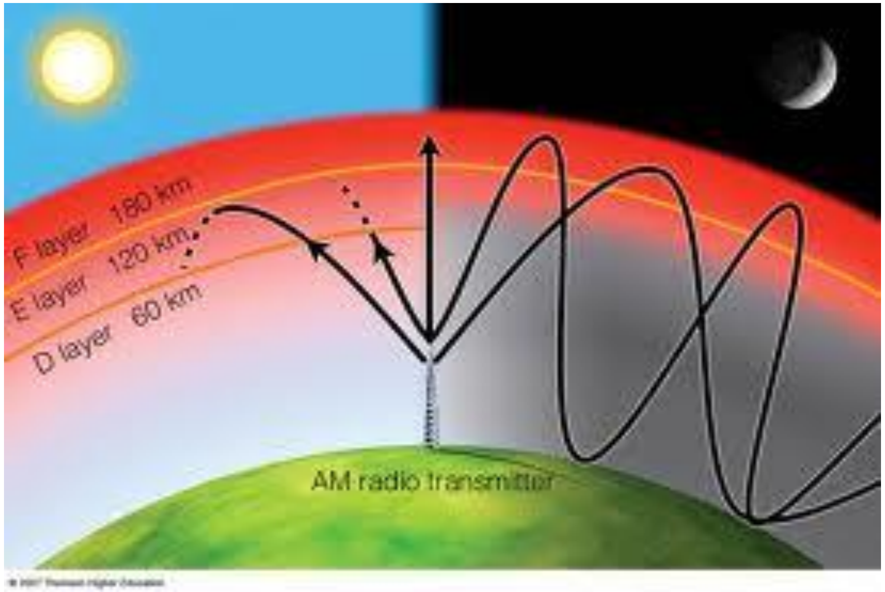
Radar

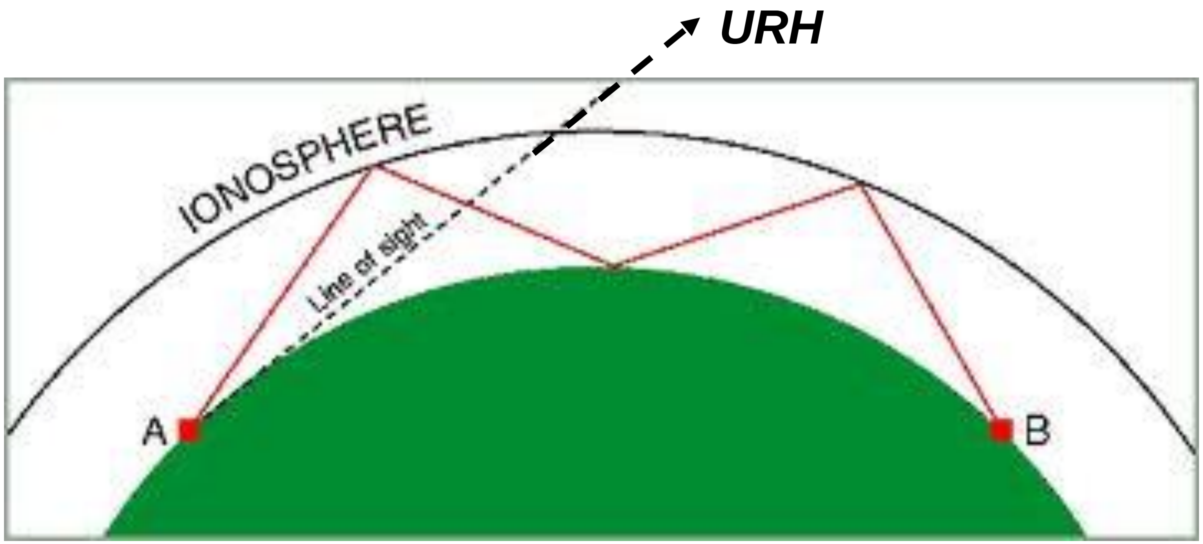
Rádiócsillagászat

Antenna reflektor

Reflexió, transzmisszió, abszorpció V.



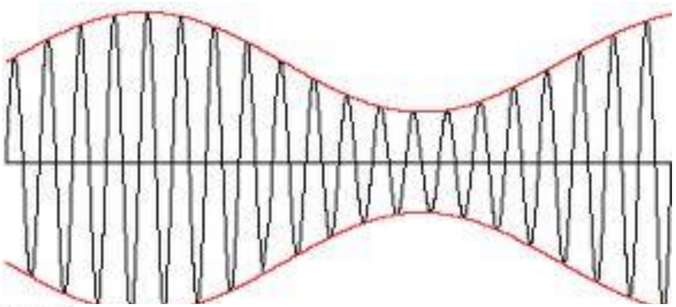




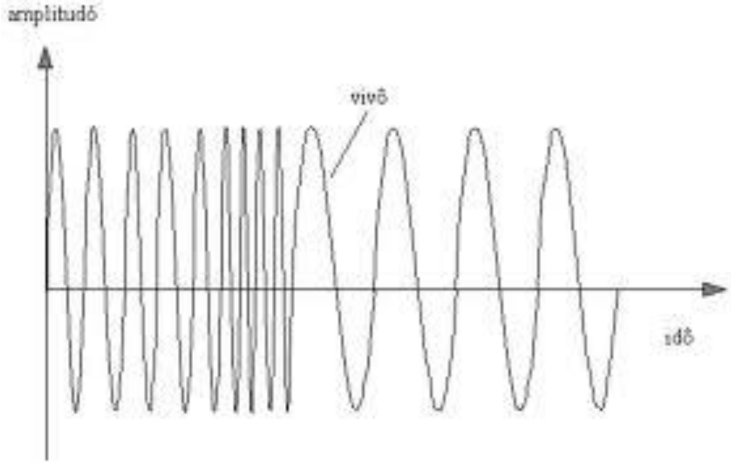
$$R = R(\omega) \text{ és } \sigma = \sigma(\omega)$$

Kommunikáció I.

Moduláció:

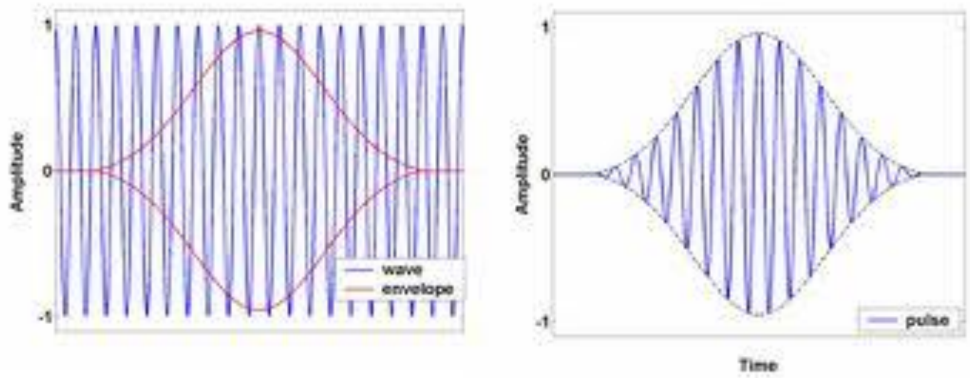


Amplitúdó moduláció:

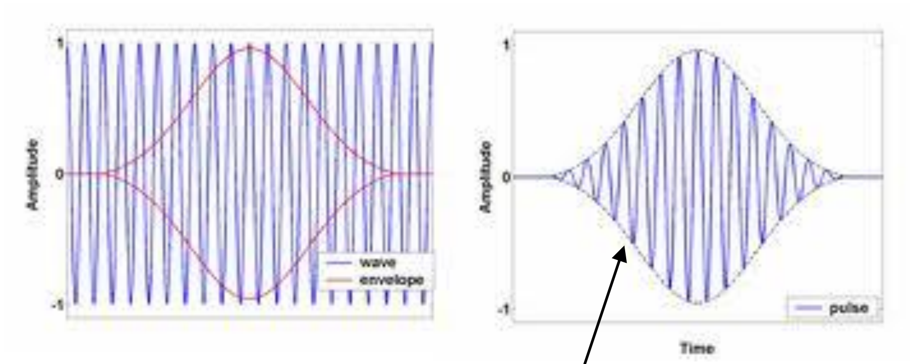


Frekvencia moduláció:

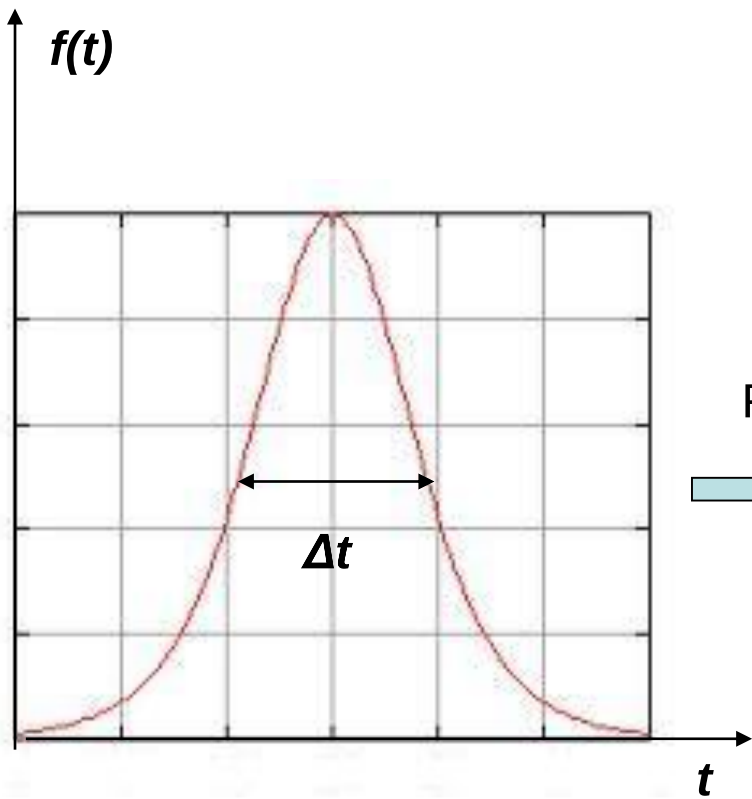
Hullámcsomag (impulzus):



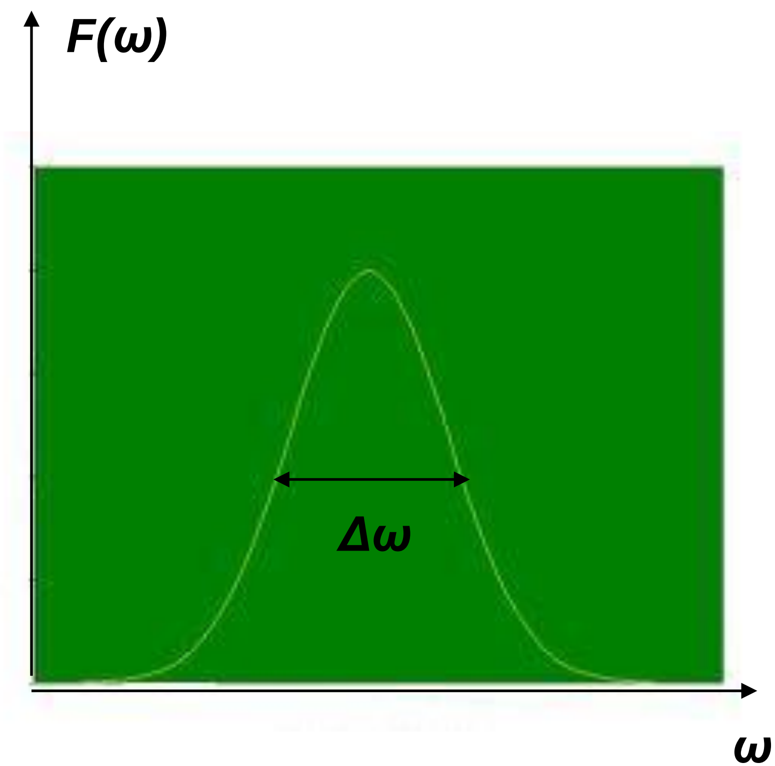
Kommunikáció II.



Burkoló fgv.: ***f(t)***



F.T.



Gauss imp.

$\Delta t \Delta \omega \approx 1$