Ondas

$$U(x,t) = A\,\text{sen}(kx - \omega t + \phi)$$

- k: número de onda
- ϕ: desfase
- A: Amplitud
- ω: frecuencia angular

$$v = \sqrt{\frac{\gamma P_0}{\rho_0}} \qquad \gamma = 1 + \frac{2}{f} = \frac{f+2}{f}$$

$$\omega = 2\pi f \qquad f = \frac{\omega}{2\pi} \qquad T = \frac{2\pi}{\omega} \qquad f = \frac{1}{T} \qquad k = \frac{2\pi}{\lambda} \qquad \lambda = \frac{2\pi}{k} \qquad v = \lambda f \qquad v = \frac{\omega}{k}$$

Ecuaciones de Maxwell

Ley de Gauss

$$\oint E \cdot d\vec{A} = \frac{Q_{enc}}{\varepsilon_0} \quad \text{y} \quad \vec{\nabla}\vec{E} = \rho\varepsilon_0$$

Ley sin nombre

$$\oint B \cdot dA = 0 \quad \text{y} \quad \vec{\nabla}\vec{B} = 0$$

Ley Lenz-Faraday

$$\oint E \cdot dl = -\frac{d}{dl}\Phi B \quad \text{y} \quad \vec{\nabla} \times E = -\frac{\partial}{\partial t}\vec{B}$$

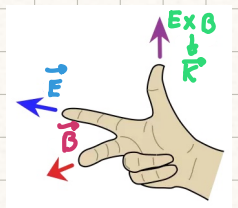
Ley de Ampere-Maxwell

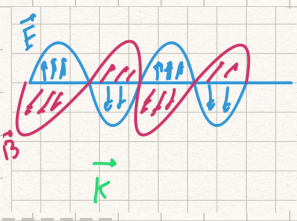
$$\oint B \cdot dl = \mu_0 \cdot i_{enc} \quad \text{y} \quad \vec{\nabla} \times B = \mu_0 \vec{J} + \mu_0 \varepsilon_0 \frac{\partial \vec{E}}{\partial t}$$

Ondas electromagnéticas

$$\vec{\nabla}^2\vec{E} = \varepsilon_0\mu_0\frac{\partial^2\vec{E}}{\partial t^2} \qquad c = \frac{1}{\sqrt{\varepsilon_0\mu_0}} \qquad \varepsilon_0\mu_0 = \frac{1}{c^2} \qquad c = 3\cdot 10^8\,[m/s] \qquad c = \lambda f$$

$$\vec{\nabla}^2 B = \varepsilon_0\mu_0\frac{\partial \vec{B}}{\partial t^2} \qquad \nabla \times B = \mu_0\varepsilon_0\frac{\partial E}{\partial t} \qquad \nabla \times E = -\frac{\partial B}{\partial t}$$





$$K \times E = \omega B \qquad B_0 = \frac{E_0}{c} \qquad E_0 = B_0 c \qquad K \cdot E = 0 \qquad K \cdot B = 0 \qquad u_{EM} = u_E + u_B$$

$$|S| = \frac{1}{\mu_0} E \cdot B \qquad \vec{S} = \frac{E \times B}{\mu_0} \qquad I = \langle S \rangle = \frac{1}{T}\int_0^T S\,dt \qquad u_{EM} = \varepsilon_0 E^2 = \frac{B^2}{\mu_0}$$

- $|S|$: intensidad instantánea
- $\vec{S}$: vector de poyting
- $I = \langle S \rangle$: Promedio

Estas formulas son validas para todas las ondas EM

$$S = u_{em} \cdot c = \varepsilon_0 E^2 c$$

Lo notar que no es un vector

Para ondas armónicas

$E(r,t) = E_0 \cos(\vec{k}\cdot\vec{r} - \omega t)$ $\quad B(r,t) = B_0 \cos(\vec{k}\cdot\vec{r} - \omega t)$ $\quad U_{em} = \varepsilon_0 E^2 \cos^2(kx - \omega t)$

$I = \langle S \rangle = \frac{E_0 B_0}{2\mu_0} = \frac{E_0^2}{2\mu_0 c} = \frac{1}{2}\sqrt{\frac{\varepsilon_0}{\mu_0}}E_0^2 = \frac{1}{2}\varepsilon_0 c E_0^2$ $\quad P = \oint_V S \cdot dA$ $\quad \frac{dP}{dV} = \frac{\vec{S}}{c^2}$ $\quad P = \frac{F}{A} = \frac{dP}{dt \cdot A}$

$\frac{dP}{A dt} = \frac{1}{\mu_0}\frac{EB}{c}$ $\quad \frac{I}{c} = P_{rad}$ Cuando es totalmente absorbida $\quad \frac{2I}{c} = P_{rad}$ Cuando es totalmente reflejada

Ondas esféricas

→ al menos indica que las ondas salen de la fuente

$\vec{E}(r) = \frac{\vec{E}_0}{r}\cos(k\cdot r - \omega t)$

Espectro electromagnético → A medida que disminuye λ, aumenta f y la energía

Ondas radio/TV (osciladores electrónicos)

· λ: 10^3 [m] → 10 [m]

Micro Ondas (magnetron)

· λ: 1 [m] $\xrightarrow[10^{-3}]{}$ 10^{-4} [m]

Infrarojas (controles, cuerpos/ondas termicas)

λ: 10^{-3} [m] → 10^{-6} [m]

Espectro Visible

λ: 700 [nm] ~ 400 [nm]

Ultra Violeta

λ: 400 [nm] → 10^{-8} [m]

Rayos X → 1 armstrong

λ: 10^{-8} [m] $\xrightarrow{10^{-10}\text{ [m]}}$ 10^{-12} [m]

Rayos T (Gamma)

λ: 10^{-12} [m] →