Physics 8.03 Vibrations and Waves

Lecture 16

EM waves meet conductors

Waveguides

Last time

- Dipole radiation
  - Total power radiated → Larmor formula
  - Scattering → charges accelerated by $E = E_0 \cos(\omega t)$ Larmor formula → radiated flux ✪ ω^4
- EM waves near perfect conductors
  - Boundary conditions

$$E_\perp = \frac{\rho_s}{\varepsilon_0} \quad \text{and} \quad E_{//} = 0$$

$$B_\perp = 0 \quad \text{and} \quad B_{//} = \mu_0 J_s$$

Last time: transmission lines

- Two conductors
- TEM modes → Both E and B field are transverse to direction of propagation, k
- Confine E and B in two dimensions
  Get wave propagation in third dimension

$$\frac{\partial V}{\partial z} = -L_0 \frac{\partial I}{\partial t}$$
$$\frac{\partial I}{\partial z} = -C_0 \frac{\partial V}{\partial t}$$

$$\frac{\partial^2 V}{\partial z^2} = L_0 C_0 \frac{\partial^2 I}{\partial t^2}$$
$$\frac{\partial^2 I}{\partial z^2} = L_0 C_0 \frac{\partial^2 V}{\partial t^2}$$

$$Z_0 = \sqrt{\frac{L_0}{C_0}}$$

Waveguides

- Single conductor
- TE or TM mode, but not TEM
- Cutoff frequency