LE 428
Antenna Engineering





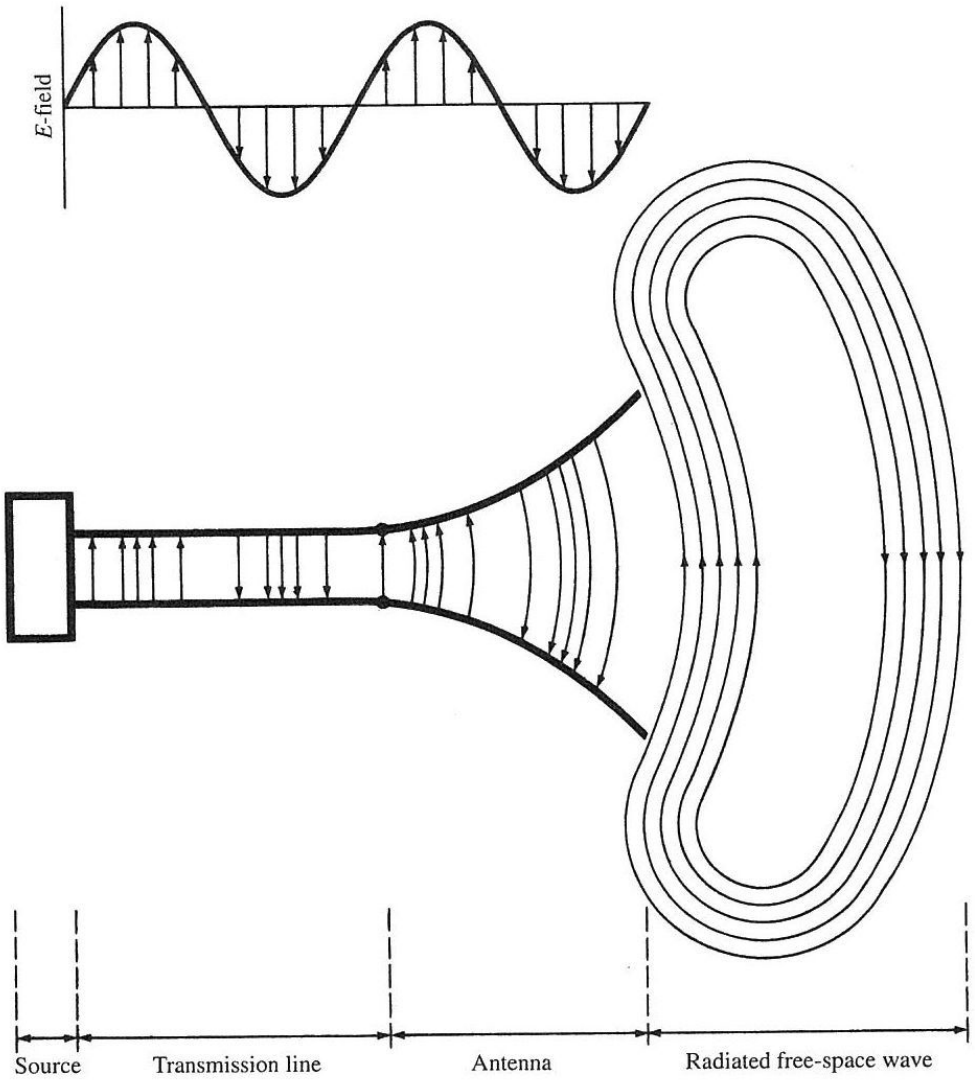

Chapter 1 : Antennas

- Introduction
- Types of antennas
- Radiation mechanism
- Historical development

Definition

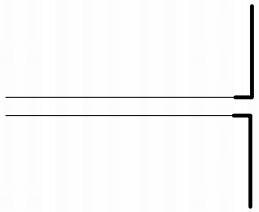
- **Definition of Antennas**
  - **Webster's : A usually metallic device (as a rod or a wire) for radiating and receiving radio waves**
  - **IEEE's : A means for radiating or receiving radio waves**
- **In short, the transitional device (i.e., a transducer) between free-space and a guiding device**

Antenna as a transition device

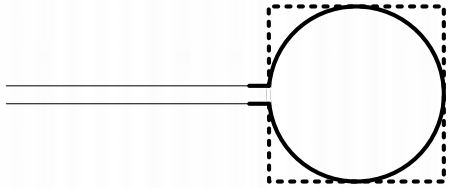


Types of Antennas

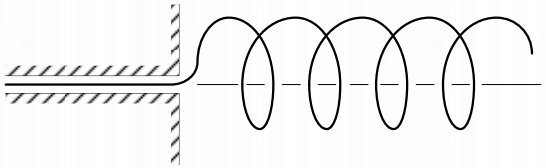
- **Wire Antennas**



Dipole

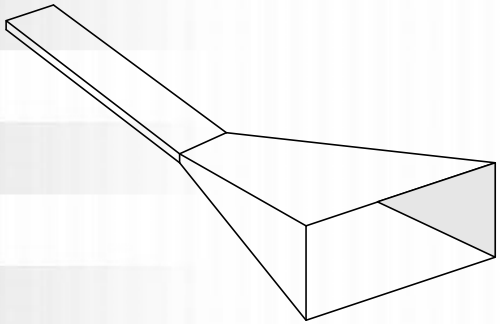


Circular (square) loop

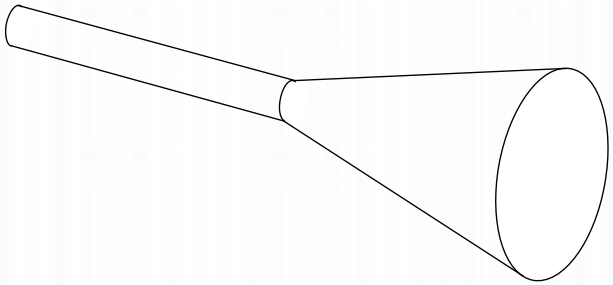


Helix

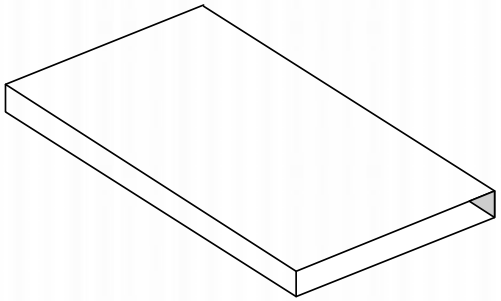
- **Aperture Antennas**



Pyramidal horn



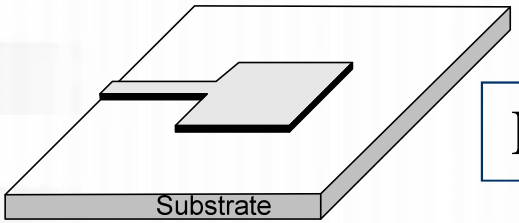
Conical horn



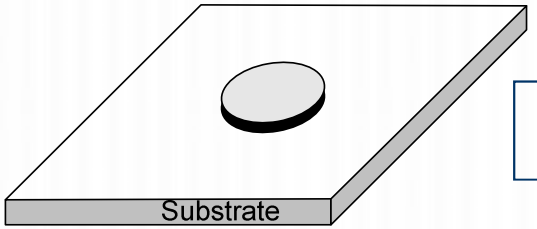
Rectangular waveguide

Types of Antennas (cont'd)

- **Microstrip Antennas**

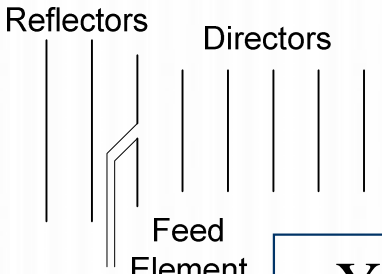


Rectangular

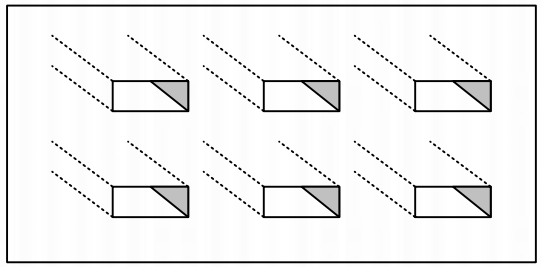


Circular

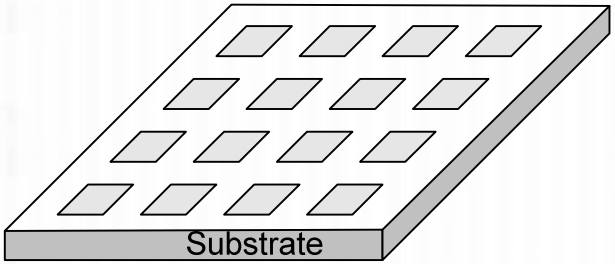
- **Array Antennas**



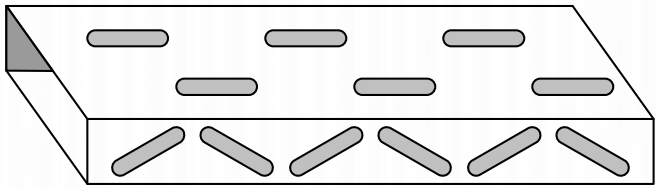
Yagi-Uda



Aperture array



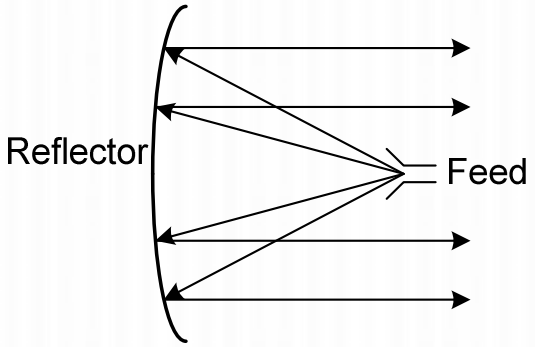
Microstrip patch array



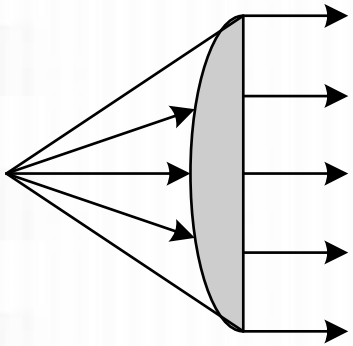
Waveguide slot antenna array

Types of Antennas (cont'd)

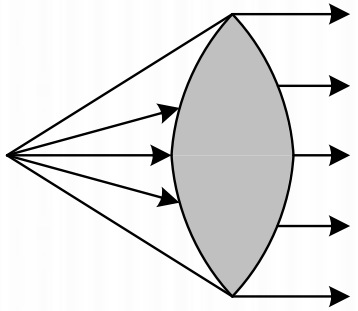
- **Reflector Antennas**



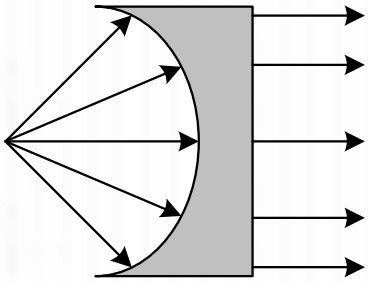
- **Lens Antennas**



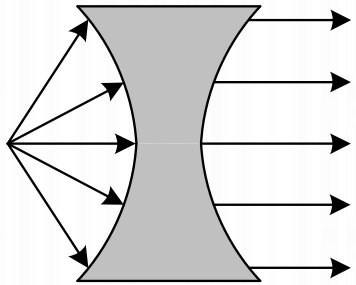
Convex-plane



Convex-convex



Concave-plane



Concave-concave

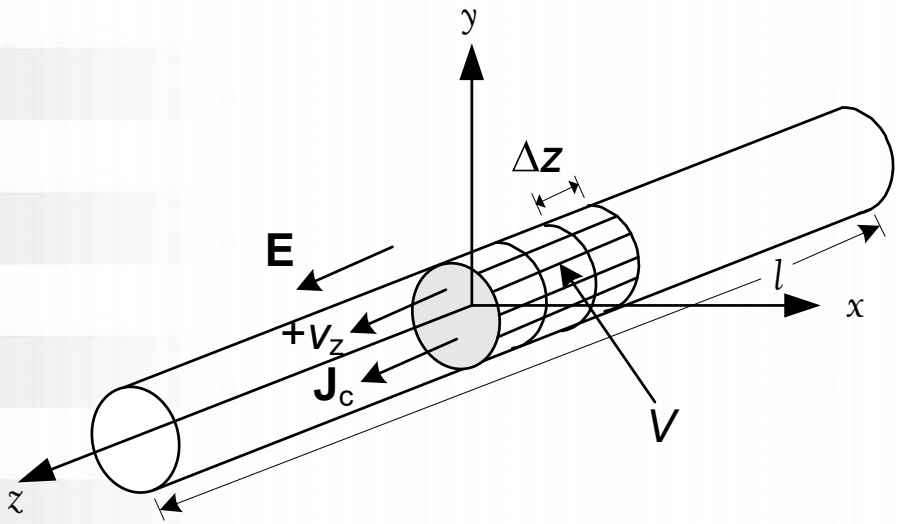
Radiation Mechanism

Current density J_z [A/m^2]: $J_z = q_v v_z$, q_v [C/m^3]

J_s [A/m]: $J_s = q_s v_z$, q_s [C/m^2]

I_z [A]: $I_z = q_l v_z$, q_l [C/m]

Time-varying current: $\dfrac{dI_z}{dt} = q_l \dfrac{dv_z}{dt} = q_l a_z$



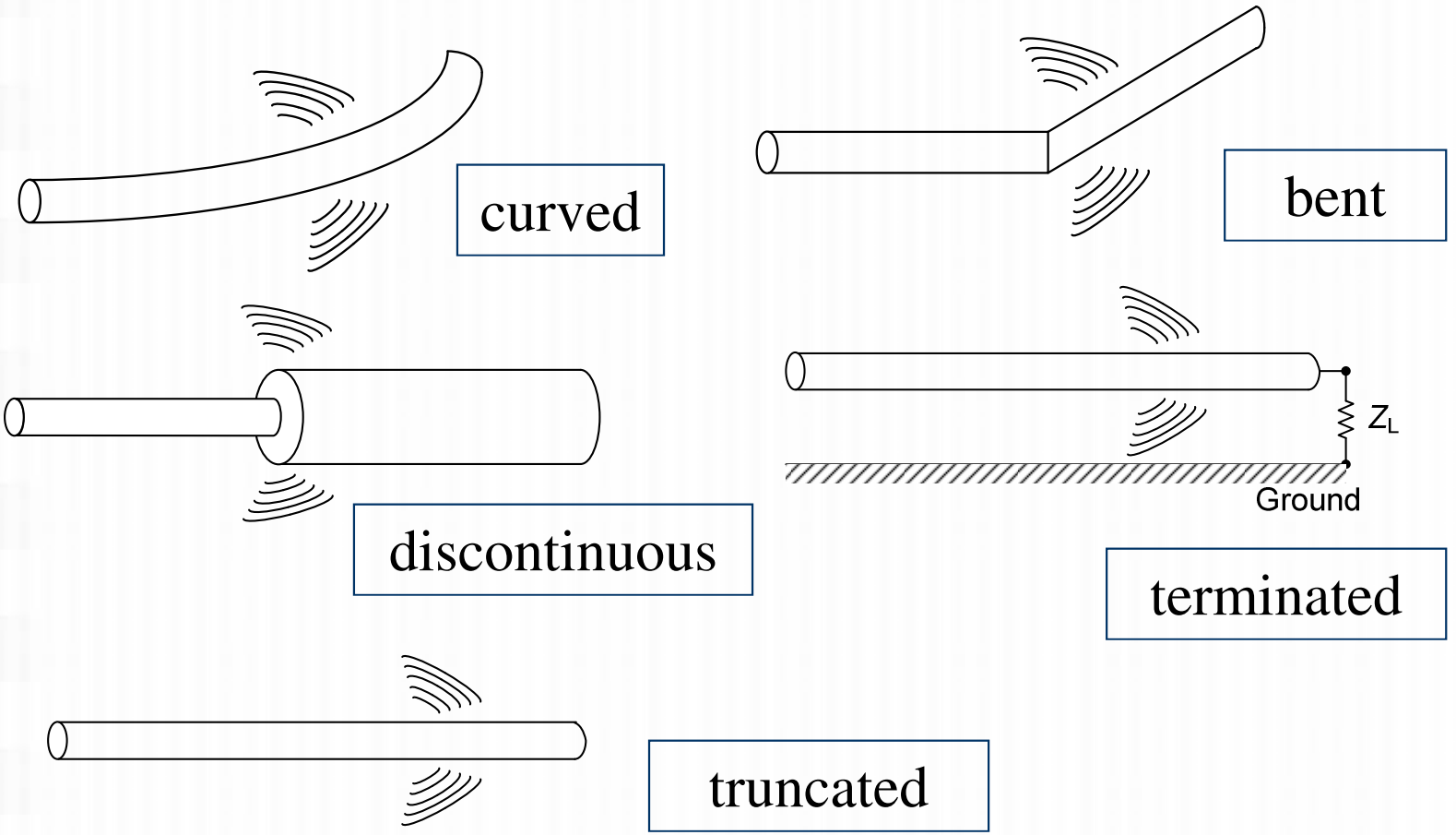
$$l\frac{dI_z}{dt} = lq_l \frac{dv_z}{dt} = lq_l a_z$$

Radiation Mechanism (cont'd)

- **To create radiation, needs *a time-varying current* or *an acceleration* (*or deceleration*) *of charge*, thus**
  - No moving charge, no current, no radiation
  - Charge moving with uniform velocity:
    - No radiation if the wire is straight and of infinite length
    - Radiation if there is a discontinuity
  - Radiation if charge oscillating in a time-motion

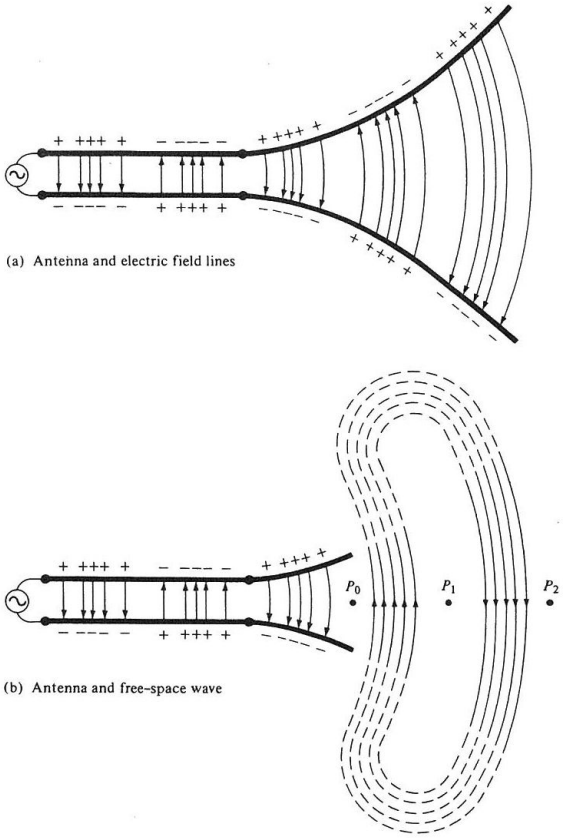
Radiation Mechanism (cont'd)

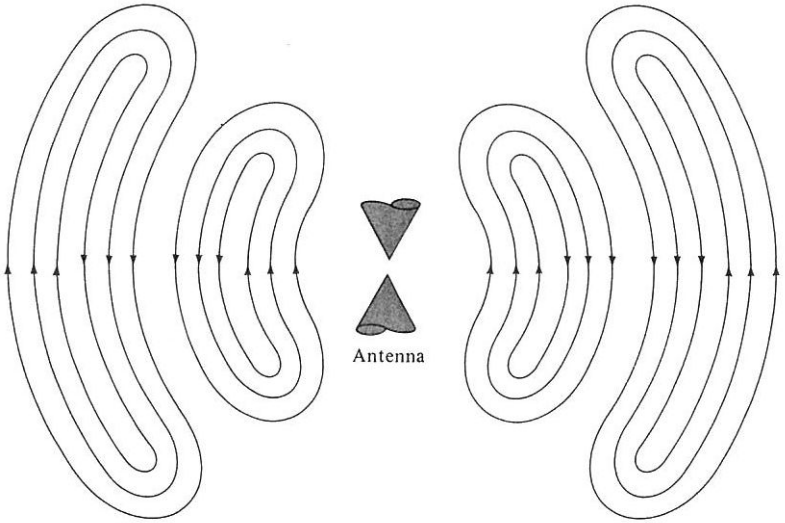
- **Single wire examples**



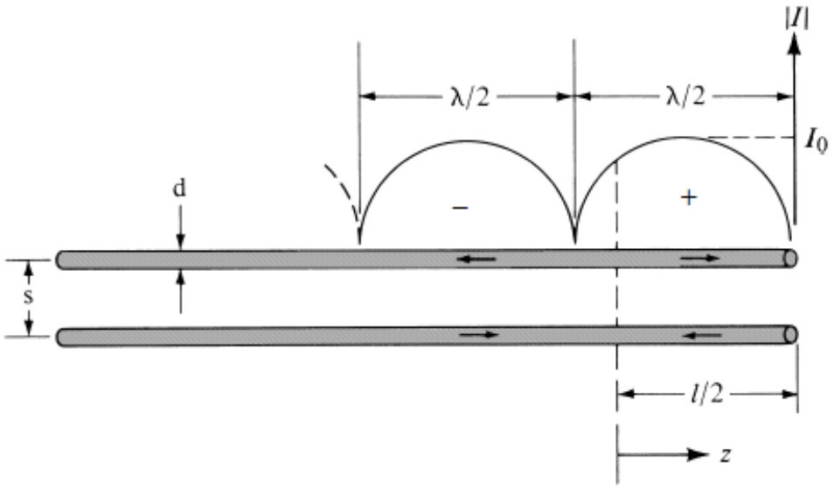
Radiation Mechanism (cont'd)

- **Two-wire examples**

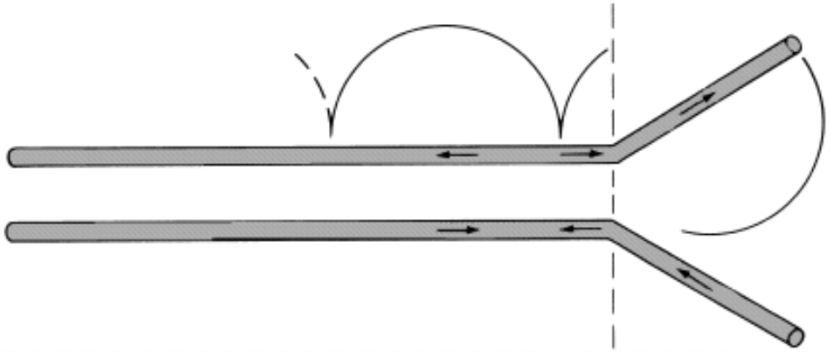




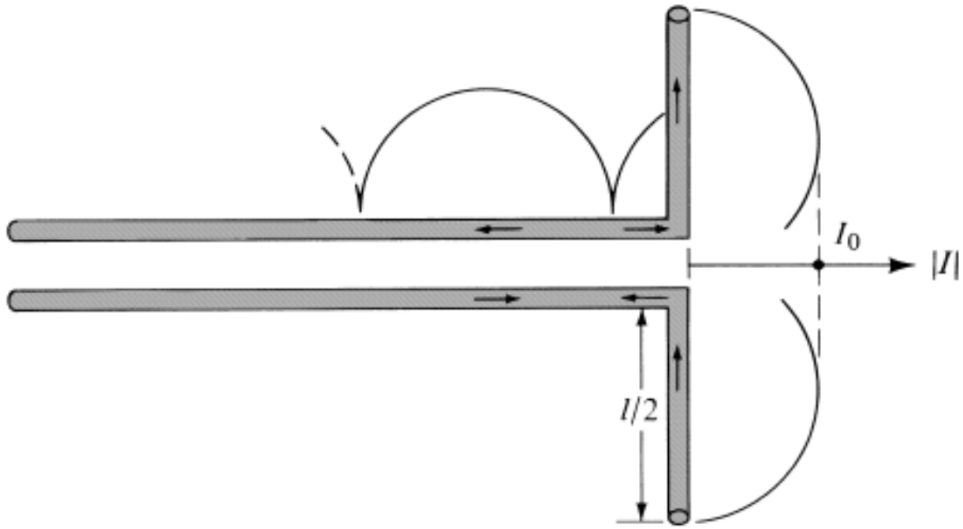
Current Distribution on two-wire



2-wire transmission line

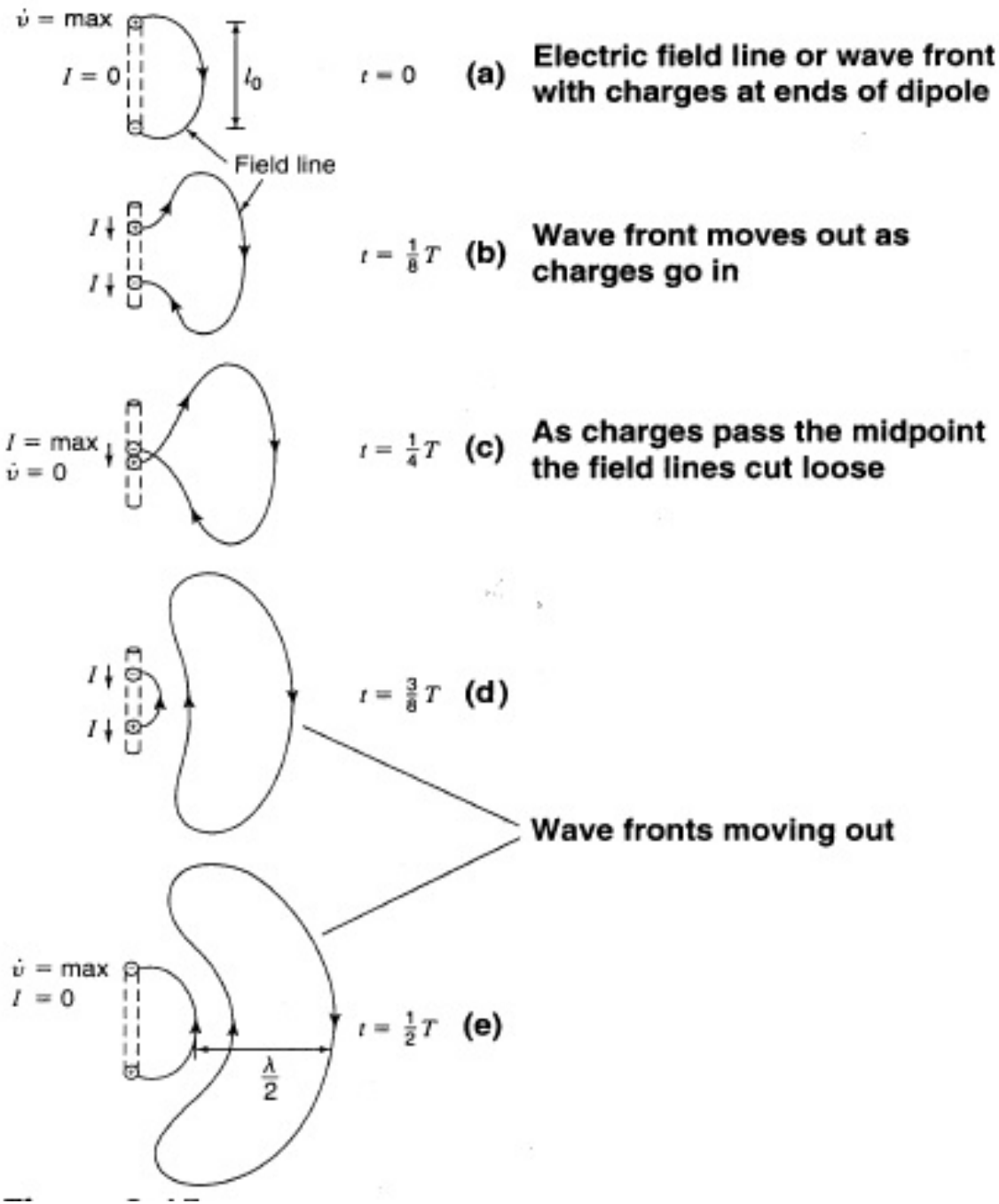


flared transmission line

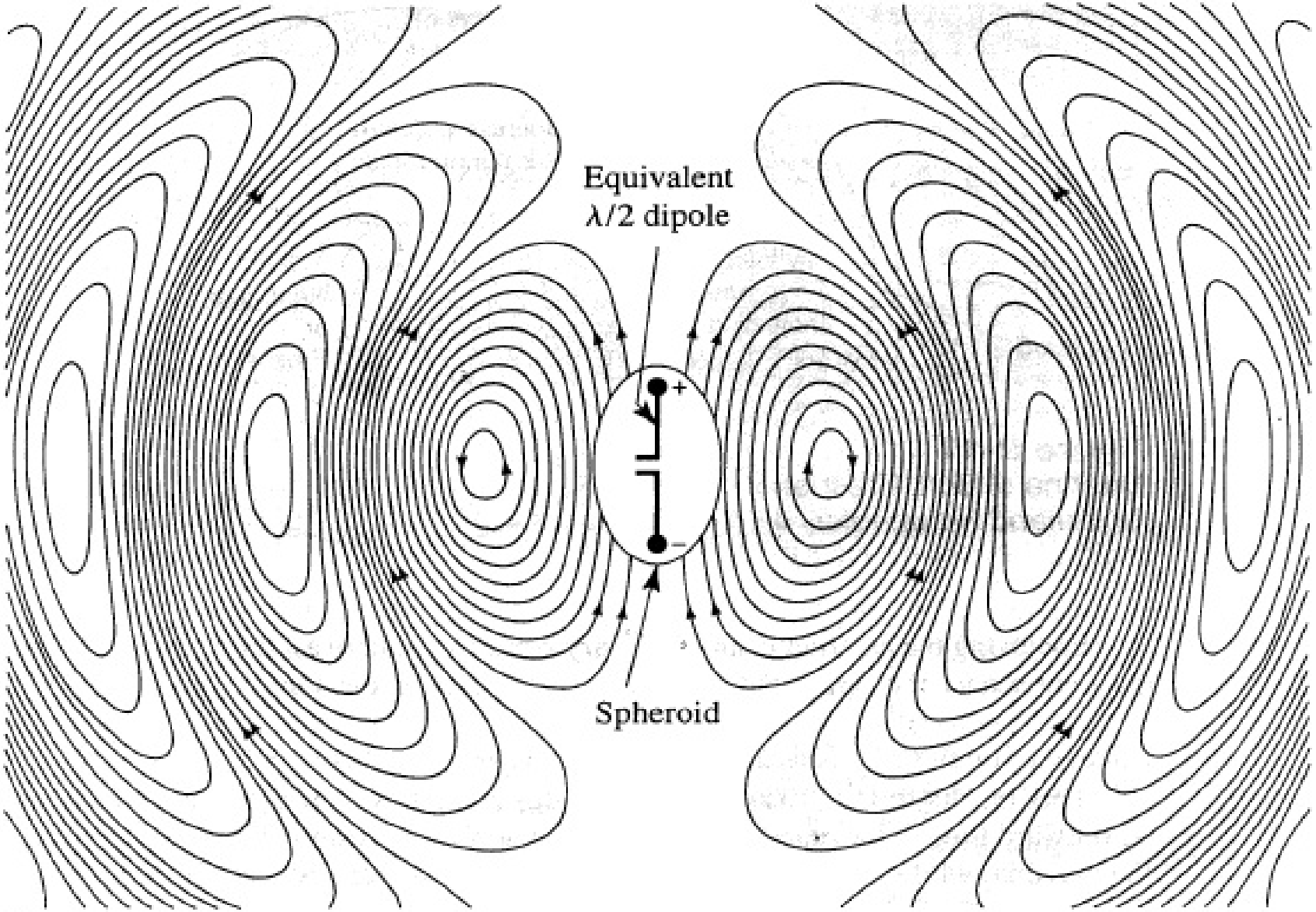


Linear Dipole

Intuitive Picture of Radiation



Intuitive Picture of Radiation



Historical Development

1873	Maxwell's equations predict electromagnetic radiation
1886	First wireless electromagnetic system (Hertz)
1896	Wireless telegraph (Marconi)
1901	First transatlantic transmission (Marconi)
1904	Radio broadcasting development; First radio receiver; First commercial broadcasting station

Historical Development (cont'd)

1923	Television broadcasting development; Yagi-Uda antenna
1938	Radar system development
1962	Satellite communication begins (1st commercial satellite launched)
1978	First GPS satellite was launched
1979	First cellular phone network (1G)
1983	First cellular phone service in U.S.
1990s	Digital cellular phone development (2G)

Historical Development (cont'd)

1998	The start of Bluetooth
1999	WiFi standard released (802.11)
1999	First wireless LAN in Apple iBook was announced
2000	Camera phone introduced
2001	WiMAX standard released (802.16)
2004	WiFi devices (PDA, cell-phone, etc.) introduced
2007	Smart phone introduced (iphone)