Definitions

- **HPBW:** half power beamwidth (HPBW) can be defined as the angle subtended by the half power points of the main lobe.

- **Main Lobe:** **R**adiation lobe containing the direction of max. radiation.

- **Minor Lobe**: All the lobes other then the main lobe are called the minor lobes.

✓ These represent the radiation in undesired directions.
✓ The level of minor lobes is usually expressed as a ratio of the power density in the lobe in question to that of the major lobe.
✓ This ratio is called as the side lobe level (expressed in decibels).

- **Back Lobe**: This is the minor lobe diametrically opposite the main lobe.

- **Side Lobes**: These are the minor lobes adjacent to the main lobe and are separated by various nulls.

✓ Generally the largest among the minor lobes.
✓ In most wireless systems, minor lobes are undesired. Hence a good antenna design should minimize the minor lobes.

Radiation pattern

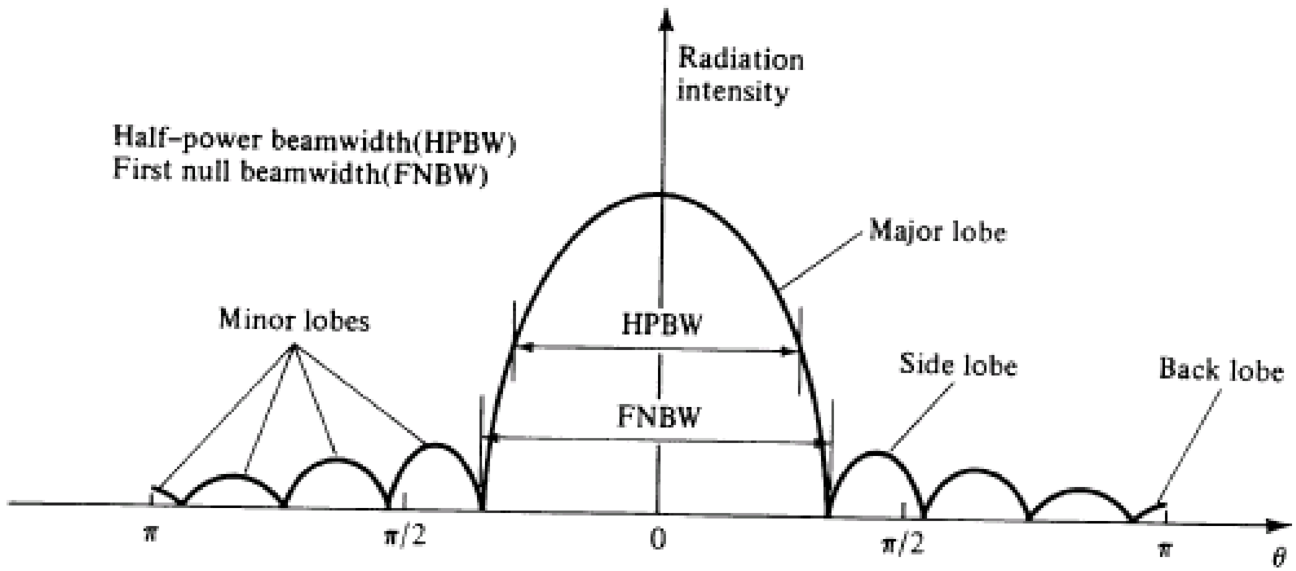
- Far field patterns
- Field intensity decreases with increasing distance, as 1/r
- Radiated power density decreases as $1/r^2$
- Pattern (shape) independent on distance
- Usually shown only in principal planes

$$\text{Far field}: \ r > 2\frac{D^2}{\lambda}$$

D : largest dimension of the antenna

e.g. r > 220 km for APEX at 1.3 mm !

Radiation Pattern Lobes



Half-power beamwidth (HPBW) is the angle between two vectors, originating at the pattern's origin and passing through these points of the major lobe where the radiation intensity is half its maximum.

First-null beamwidth (FNBW) is the angle between two vectors, originating at the pattern's origin and tangent to the main beam at its base. It very often approximately true that FNBW≈2·HPBW.

Radiation & Induction Fields

- The RF fields that are created around the antenna have specific properties that affect the signals transmission.
- The RF fields that are created around the antenna is called **induction field**
- The RF field that are created far away from antenna are called ***radiation field***

Radiation & Induction Fields

Two **induction fields** or areas where signals collapse and radiate from the antenna.

Reactive near field **& Radiating near *field***.

The distance that antenna inductance has on the transmitted signal is directly proportional to antenna height and the dimensions of the wave

$$R > \frac{2D^2}{\lambda}$$

Radiation & Induction Fields-cont'd

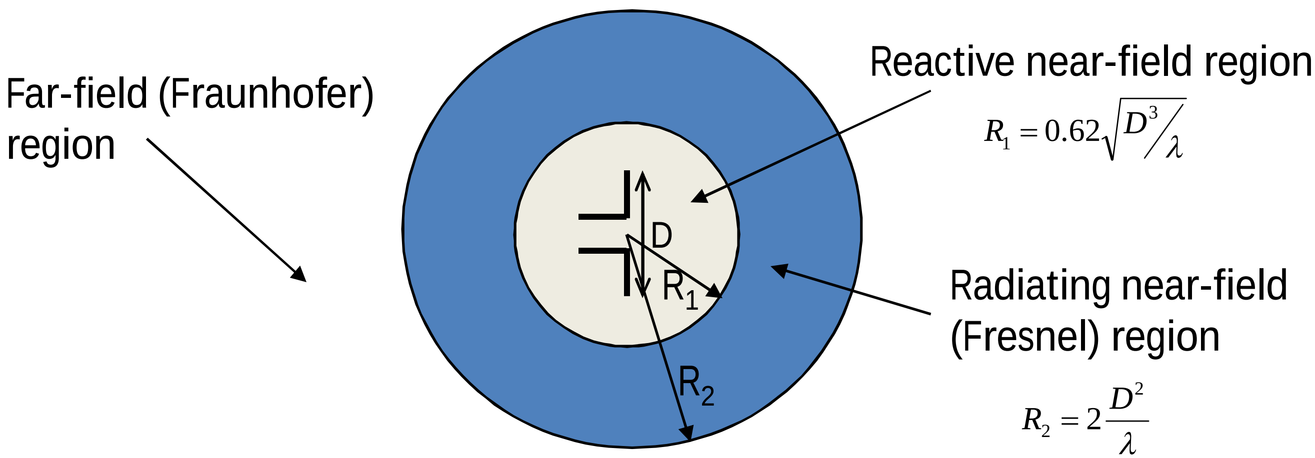
$$R > \frac{2D^2}{\lambda}$$

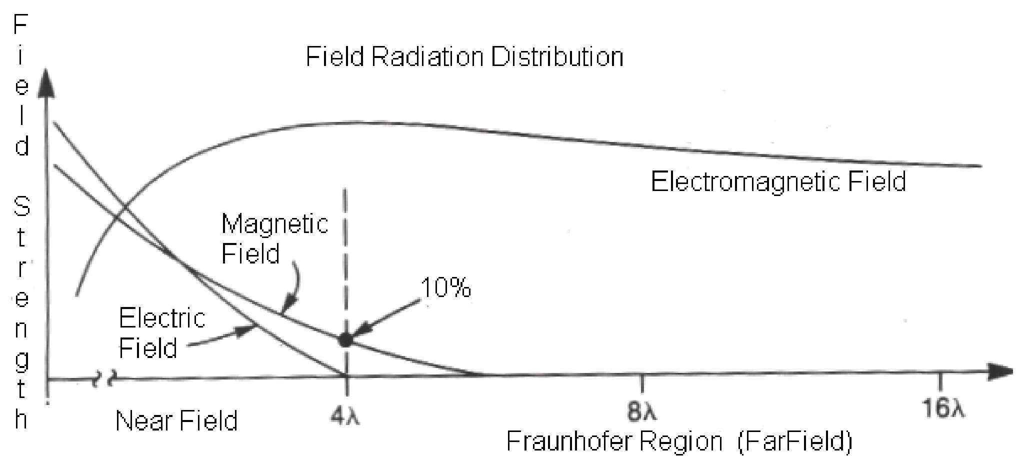
Where: R = *the distance from the antenna*

D = *dimension of the antenna*

λ = *wavelength of the transmitted signal*

Field Regions





Field Regions

- **Reactive Near Field Region**:

It is that portion of the near field region immediately surrounding the antenna where in the reactive field predominates.

$$R_1 < 0.62\sqrt{D^3/\lambda}$$

Field Regions

- **Radiating Near Field(Fresnel) or transition region**:

It is region between the reactive near field and ....

Radiating near-field (Fresnel) region

$$0.62\sqrt{\frac{D^3}{\lambda}} \leq R < 2\frac{D^2}{\lambda}$$

Radiating Near Field(Fresnel)

- ***Properties***:

1. The antenna pattern is taking shape but is not truly formed.
2. The radiation field predominates the reactive field.
3. The angular field distribution is dependent upon the distance from the antenna.
4. The radiated wave is still clearly curved(nonplanar).
5. The electric and magnetic field vectors are not orthogonal

Far-Field(Fraunher) Regions

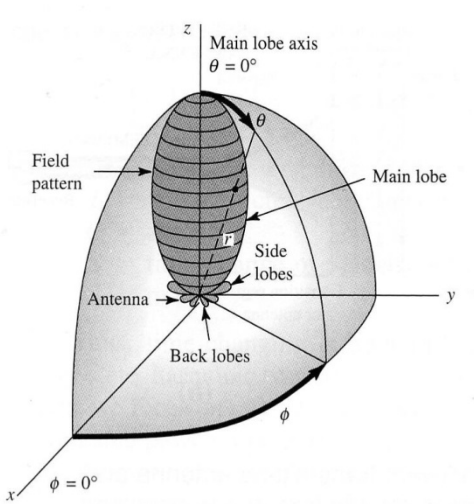
- ***The region where the angular distribution is essentially independent of the distance from antenna.***

$$R_1 > 2\frac{D^3}{\lambda}$$

Properties:

1. The w/f becomes planar.
2. Radiation pattern is completely formed and does not vary with distance.
3. E and M field vectors are orthogonal to each other.
4. The angular field distribution is independent of the radial distance.

Radiation pattern (2)

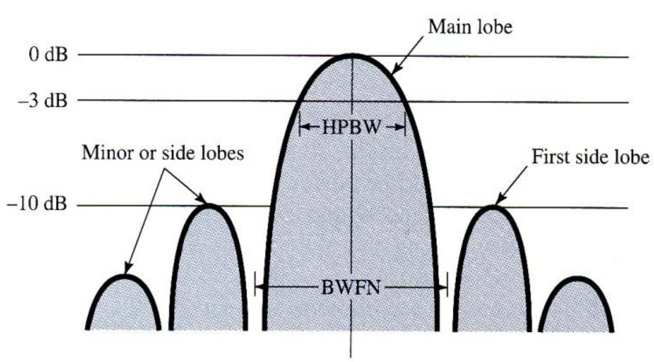


Field patterns

$$E_\theta(\theta,\phi) \qquad E_\phi(\theta,\phi)$$

+ phase patterns

$$\varphi_\theta(\theta,\phi) \qquad \varphi_\phi(\theta,\phi)$$



HPBW: half power beam width

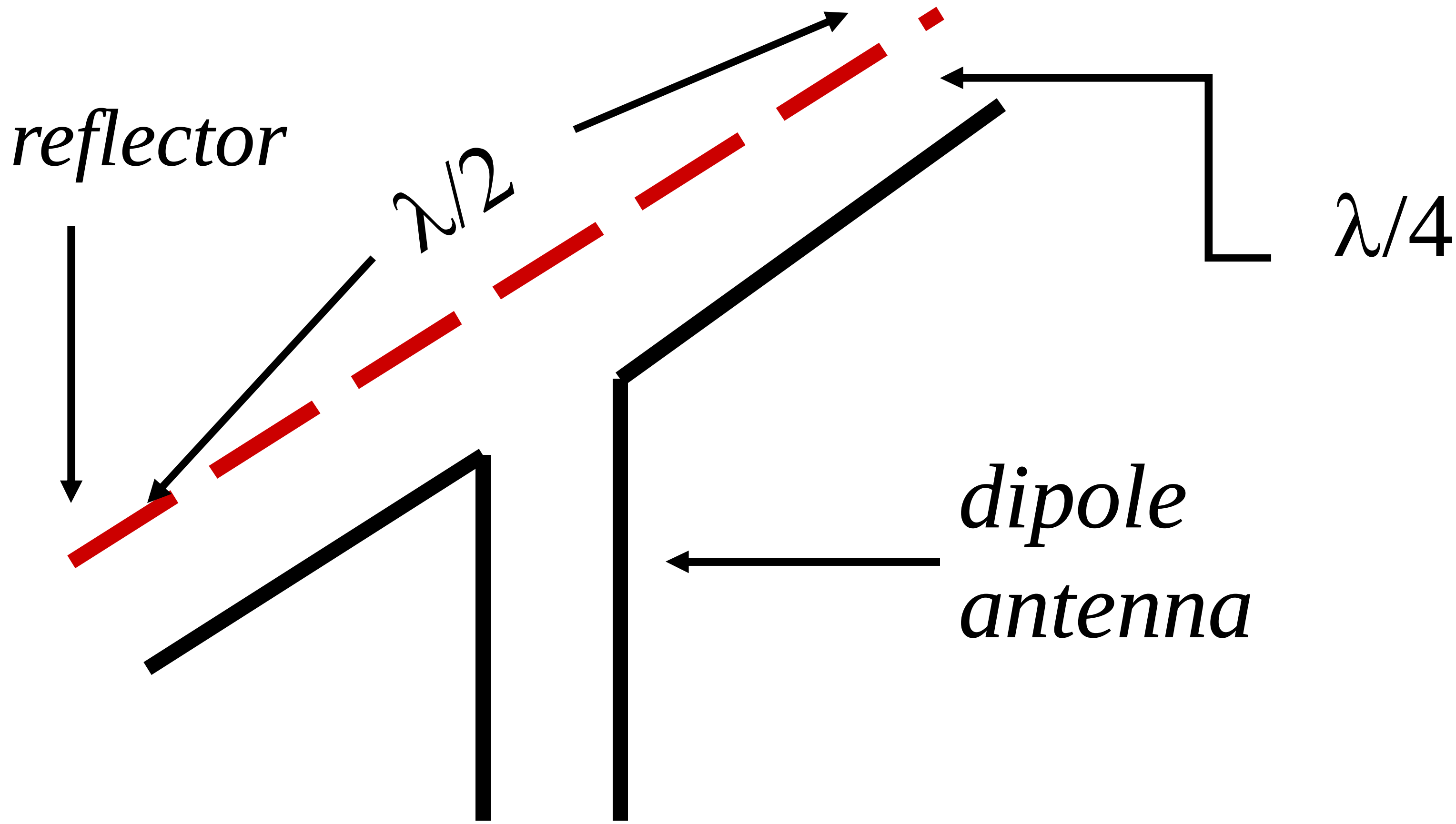
$$P(\theta,\phi) = \frac{E_\theta^2(\theta,\phi) + E_\phi^2(\theta,\phi)}{Z_0} r^2$$

$$P_n(\theta,\phi) = \frac{P(\theta,\phi)}{P(\theta,\phi)_{\max}}$$

Yagi-Uda Antenna

- The *Yagi-Uda antenna* is a simple form of a directional antenna based off of a reflector placed $\lambda/4$ from the dipole antenna’s placement. Complex analysis to define the radiated patterns are experimental rather than theoretical calculations

Yagi-Uda Antenna-cont'd



Radiation Pattern

- It is an indication of radiated field strength around the antenna.
- Power radiated from a $\lambda/2$ dipole occurs at right angles to the antenna with no power emitting from the ends of the antenna.
- Optimum signal strength occurs at right angles or 180° from opposite the antenna

Radiation Patterns

- **Radiation pattern**
  - Graphical representation of radiation properties of an antenna
  - Depicted as two-dimensional cross section
- **Beam width** (or half-power beam width)
  - Measure of directivity of antenna
- **Reception pattern**
  - Receiving antenna's equivalent to radiation pattern