Reflector Antennas

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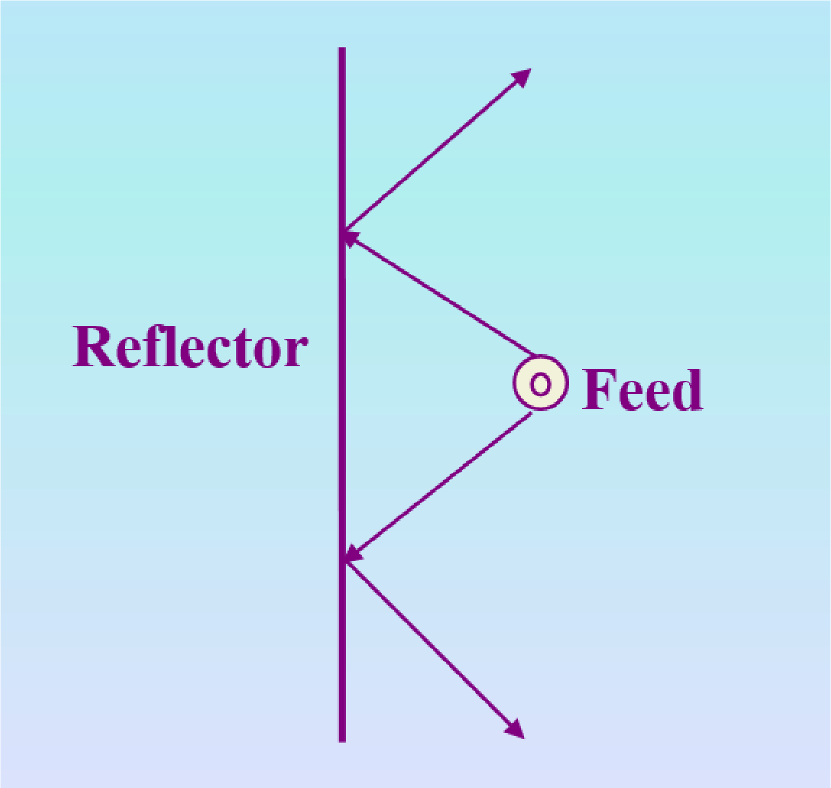
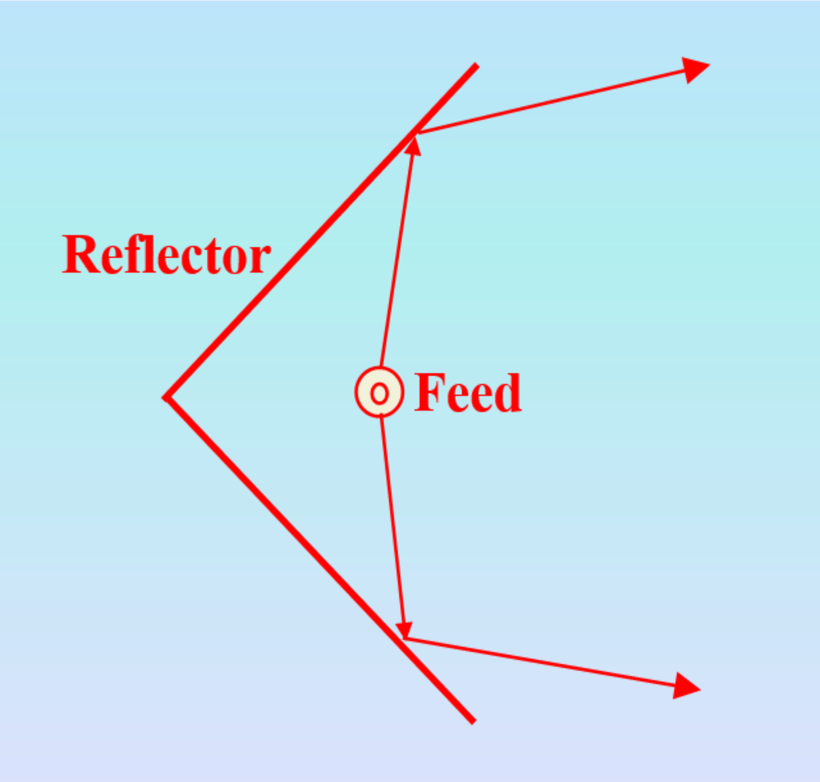
Flat Reflector Antennas

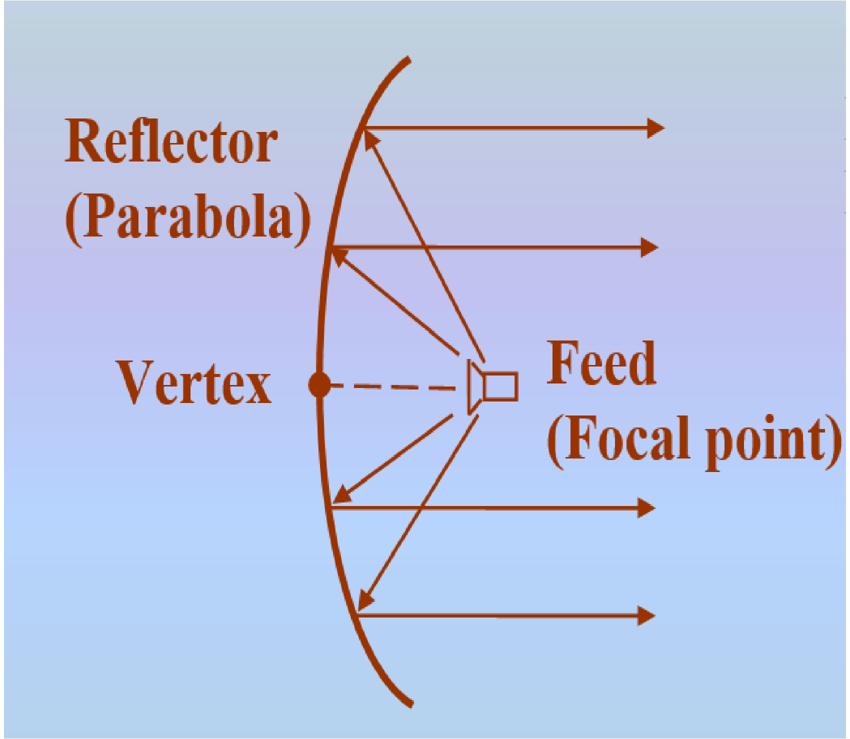




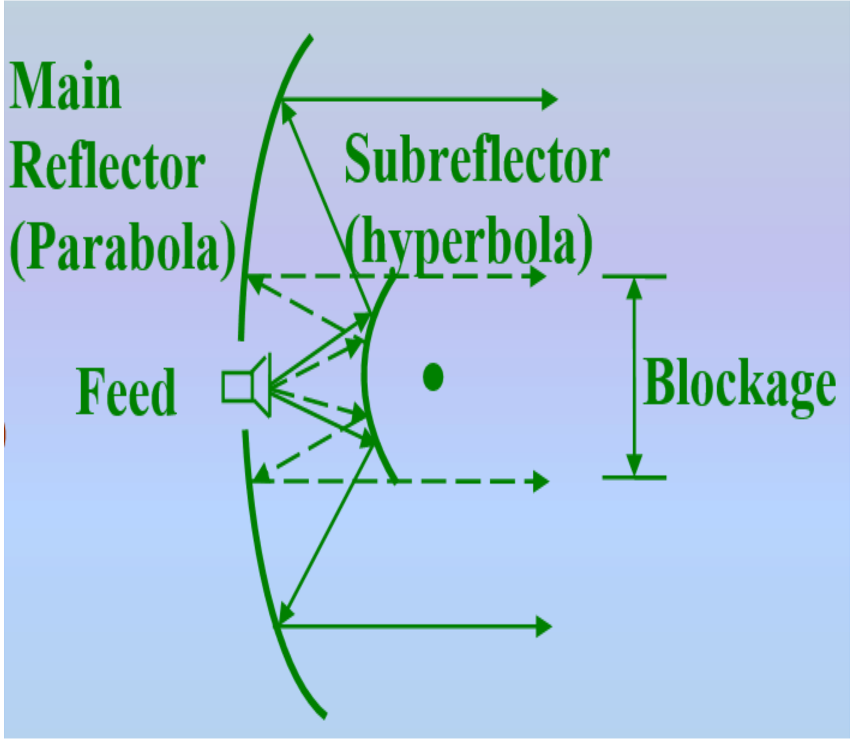
Plane

Corner

Curved Reflector Antennas

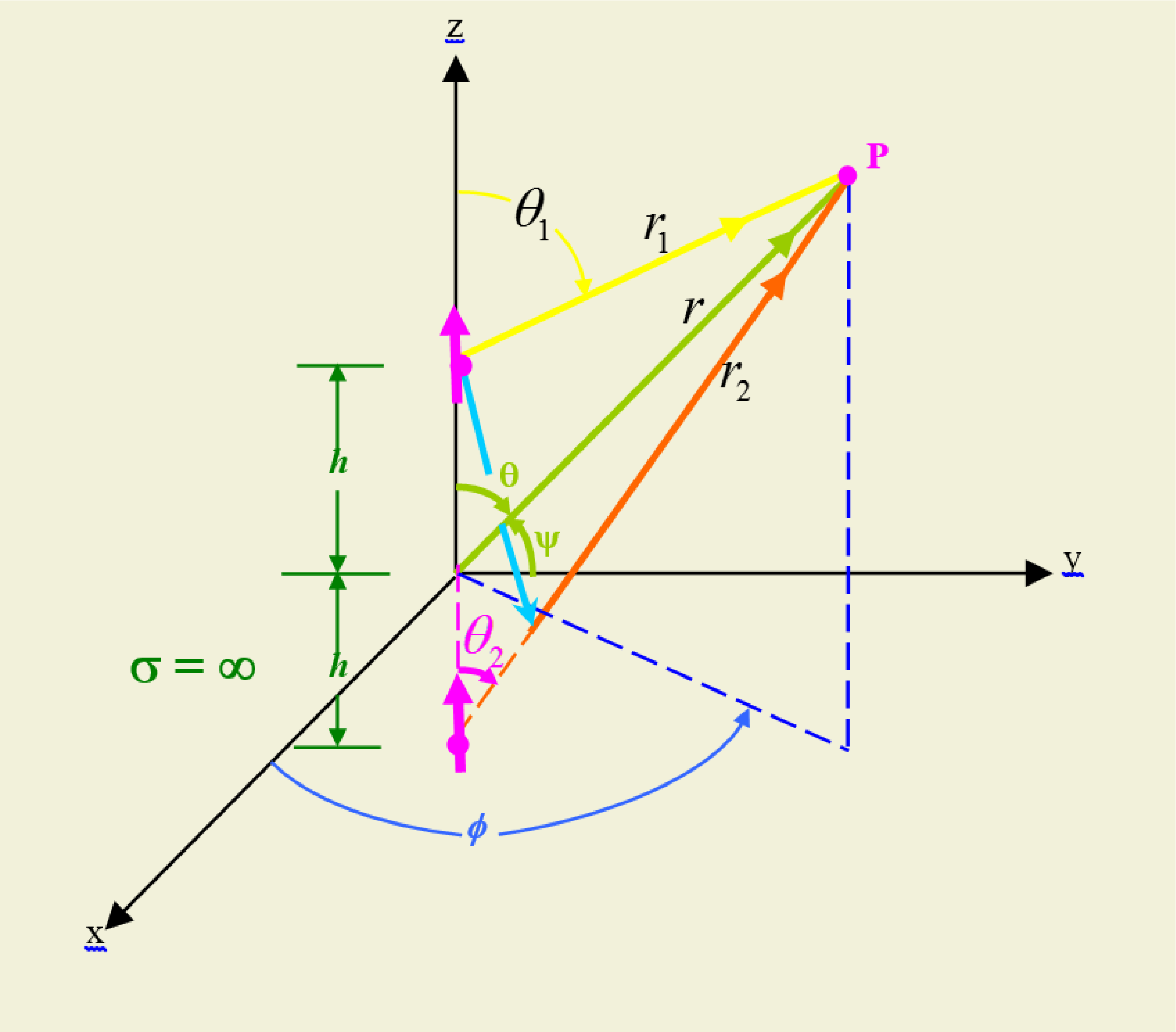


Prime Focus Reflector

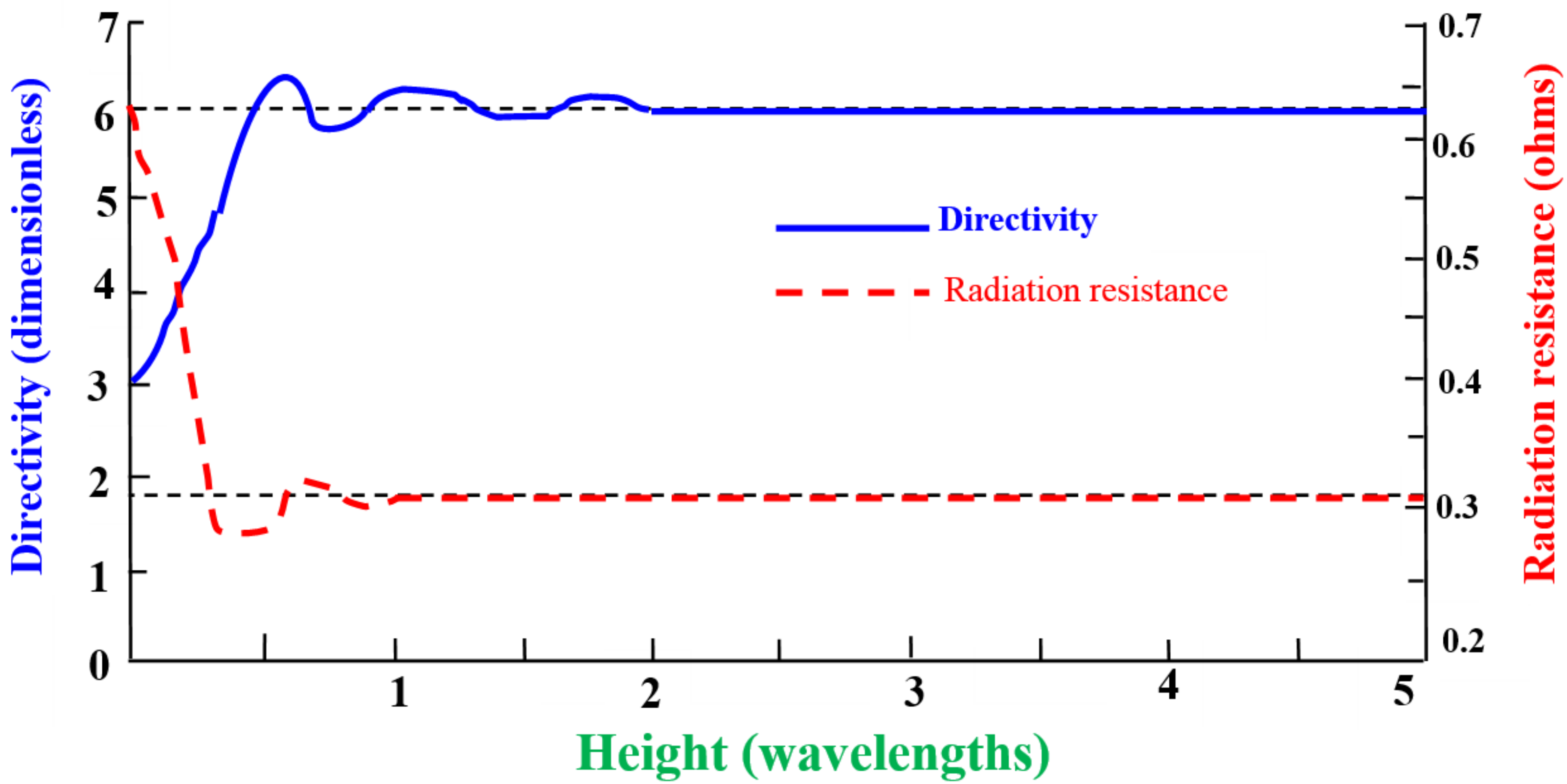


Cassegrain Reflector

Vertical Dipole Antenna over Infinite Perfect Ground Plane (Reflector)

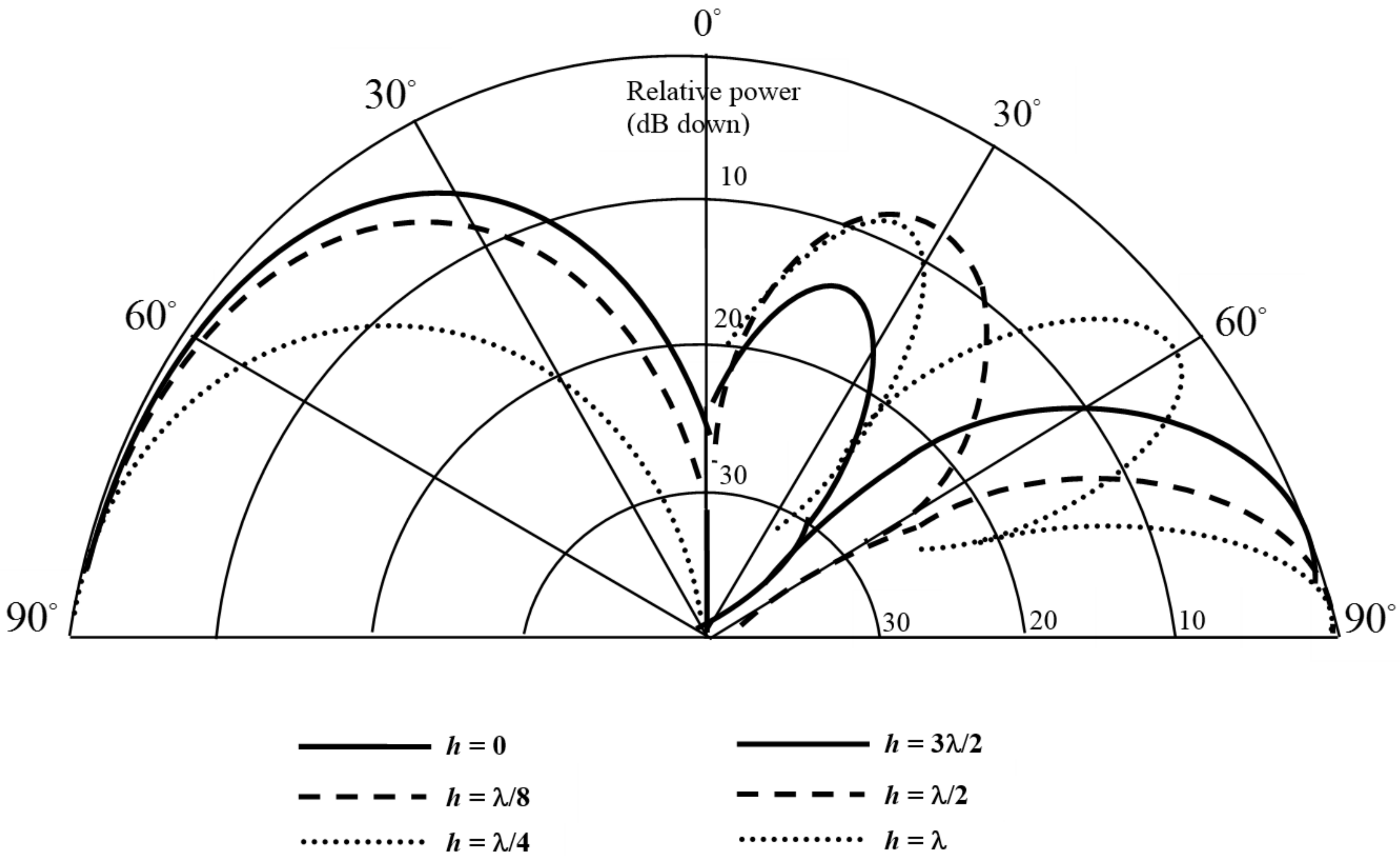


Directivity and Radiation Resistance of Vertical Dipole Antenna over Infinite Reflector



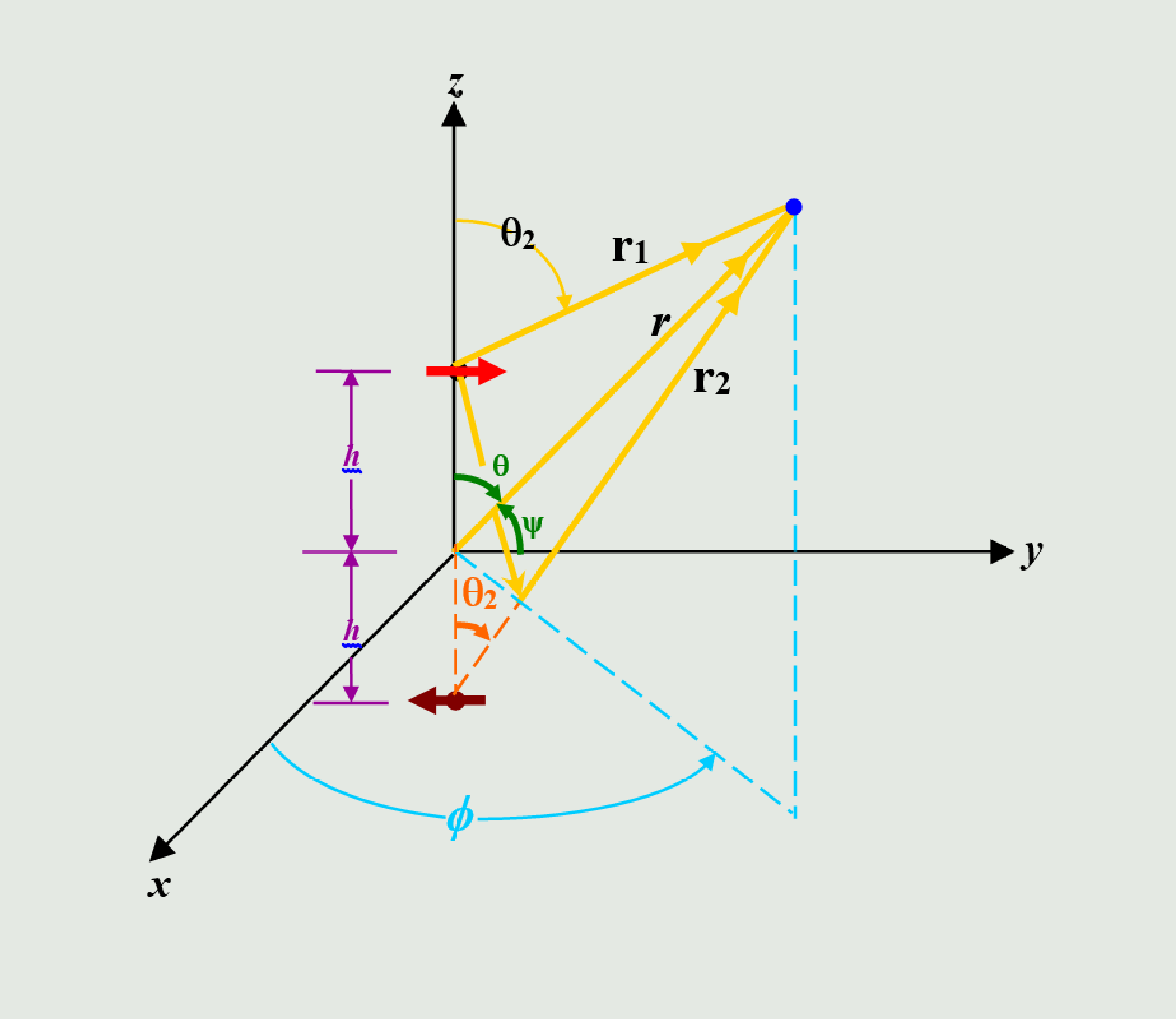
Directivity and radiation resistance of a vertical infinitesimal dipole as a function of its height above an infinite perfect electric conductor

Radiation Pattern of Vertical Dipole Antenna over Infinite Ground Plane (Reflector)

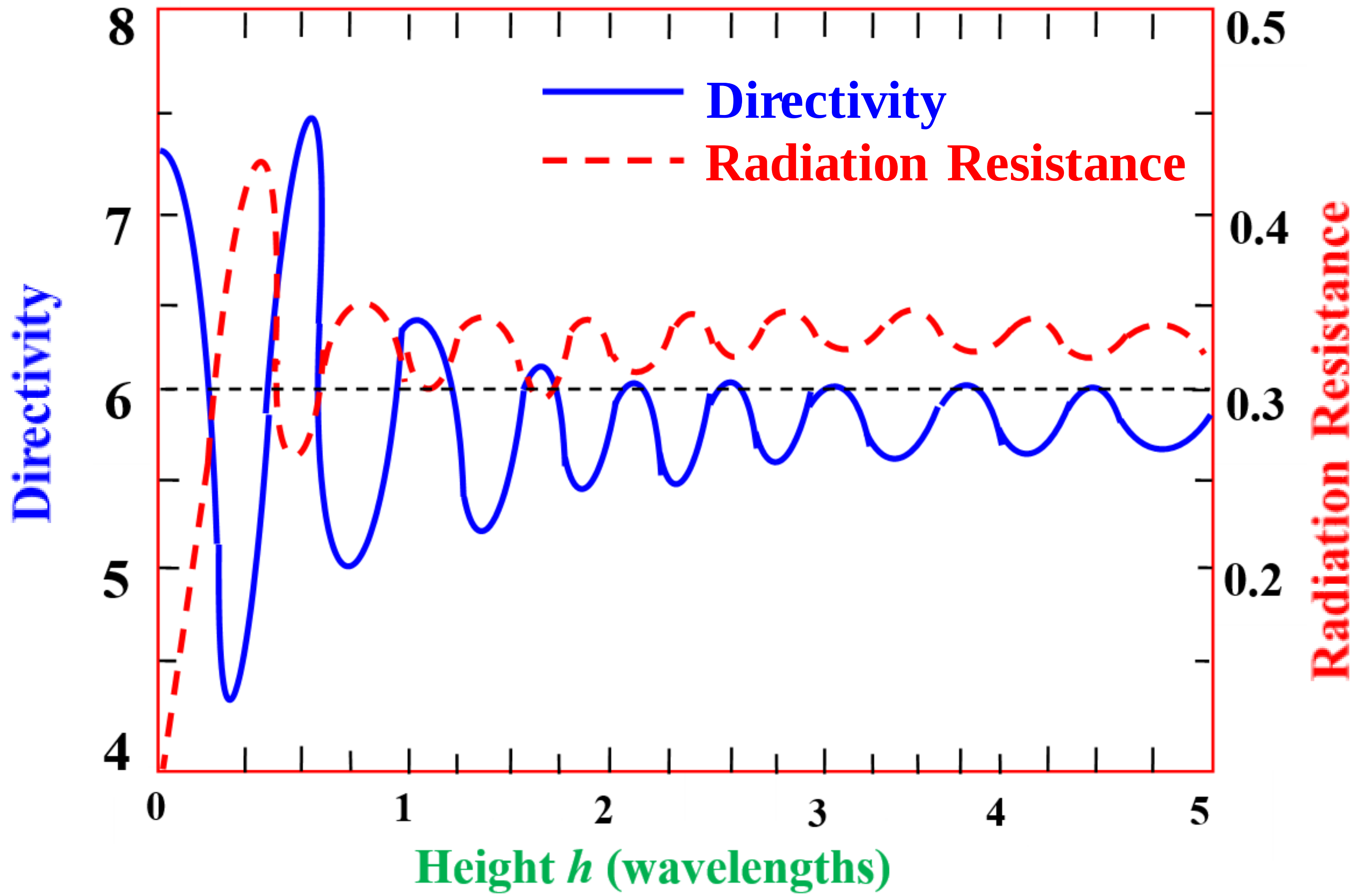


Elevation patterns of a vertical infinitesimal dipole for different heights above an infinite perfect electric conductor

Horizontal Dipole Antenna over Infinite Ground Plane (Reflector)

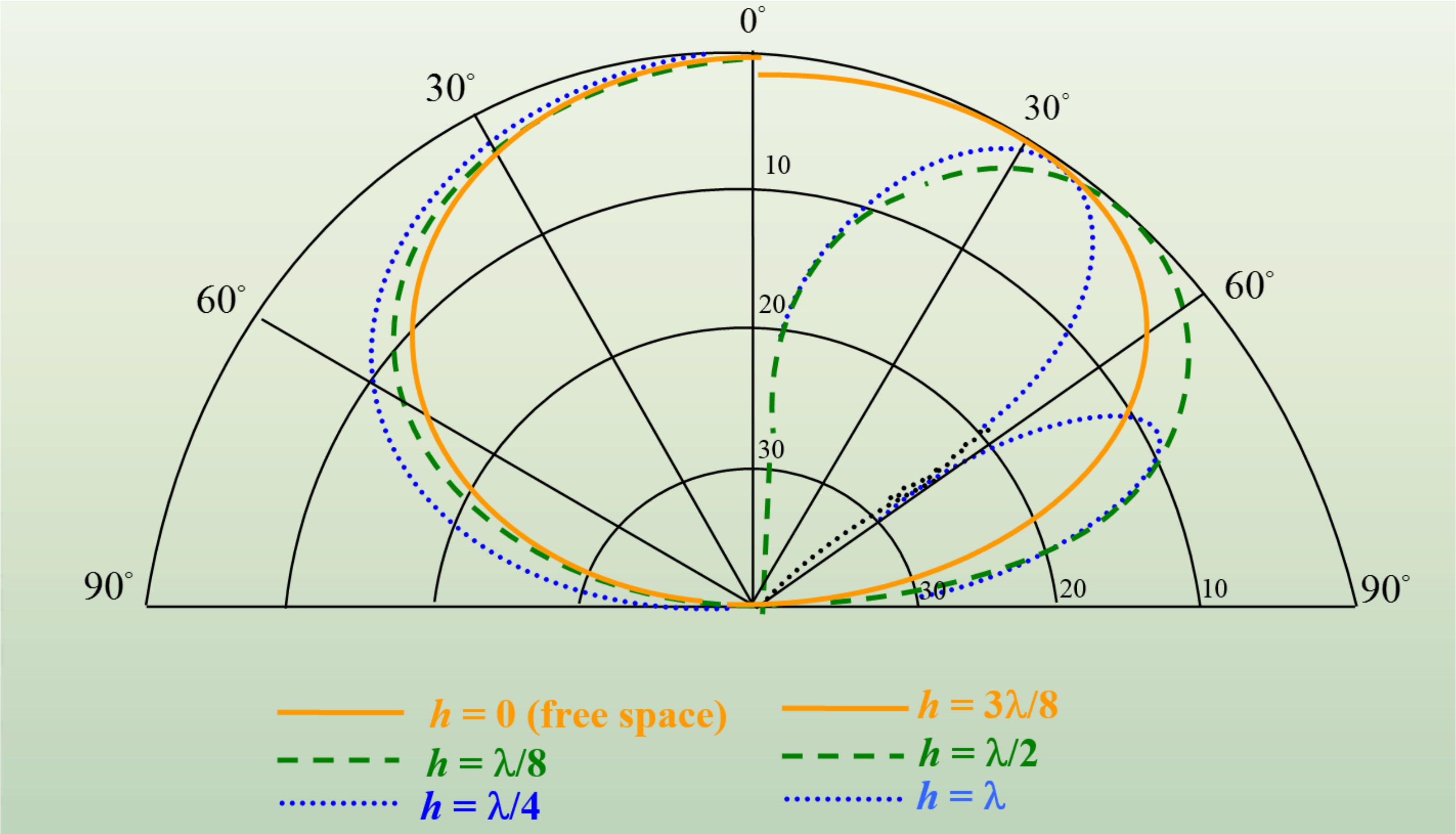


Directivity and Radiation Resistance of Horizontal Dipole Antenna over Infinite Reflector



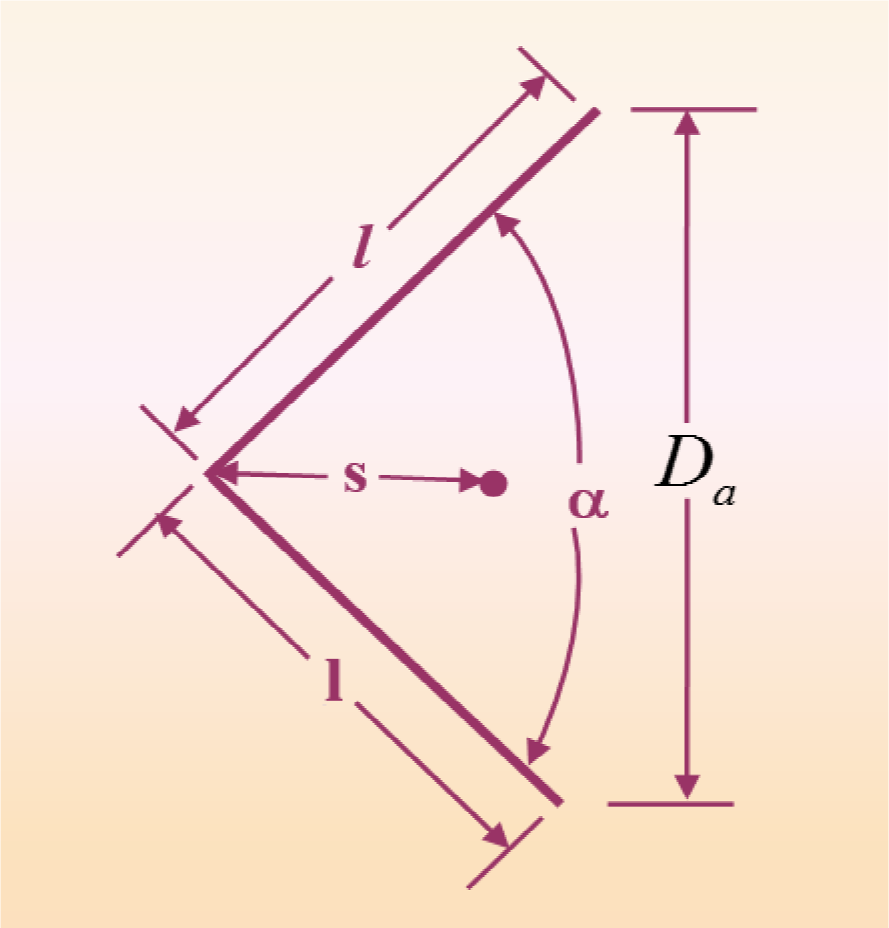
Radiation resistance and directivity of a horizontal infinitesimal electric dipole as a function of its height above an infinite perfect electric conductor

Radiation Pattern of Horizontal Dipole Antenna over Infinite Ground Plane (Reflector)

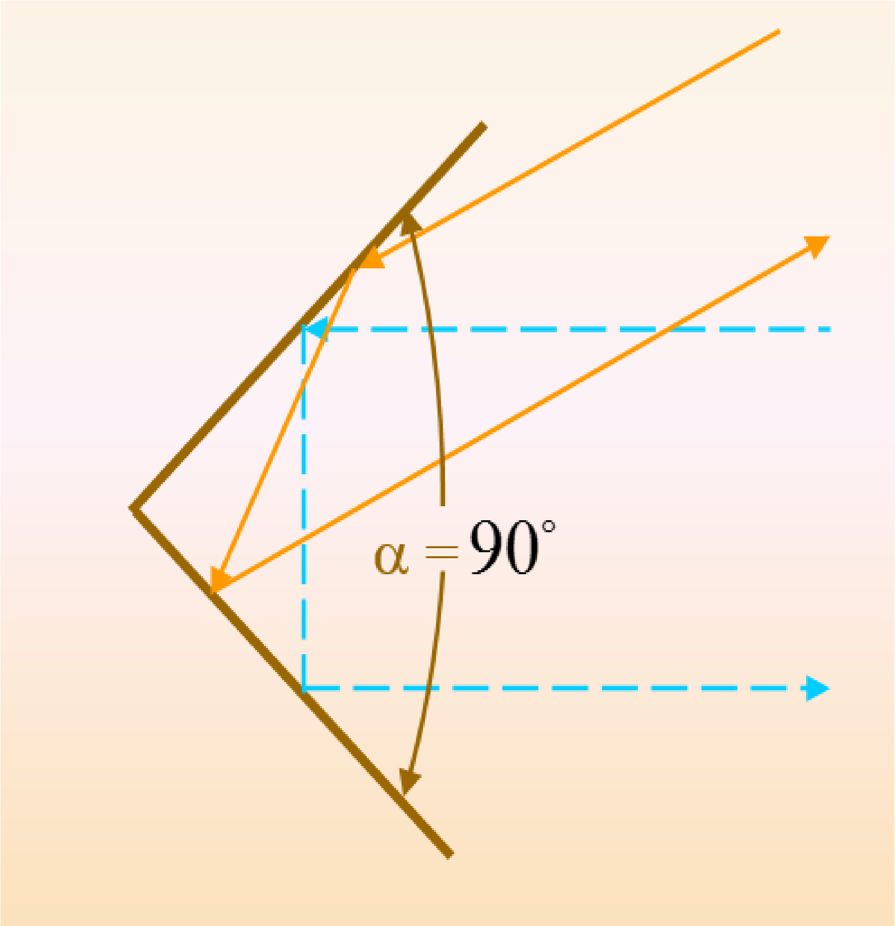


Elevation patterns of a horizontal infinitesimal dipole for different heights above an infinite perfect electric conductor

Corner Reflector Antenna

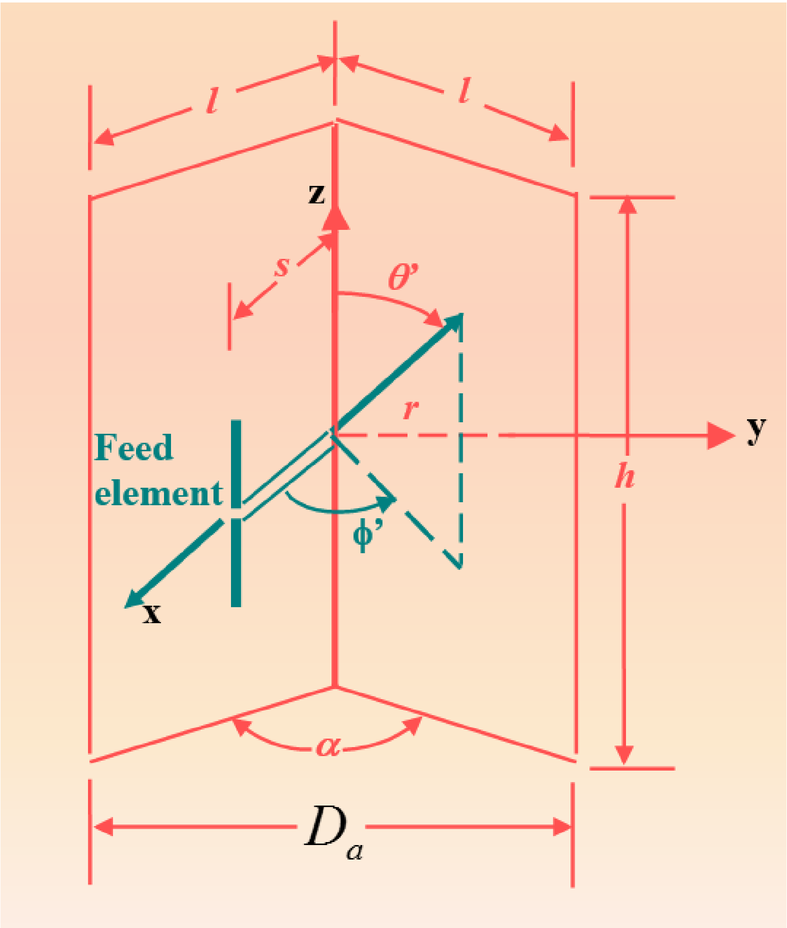


Top View of Corner Reflector Antenna

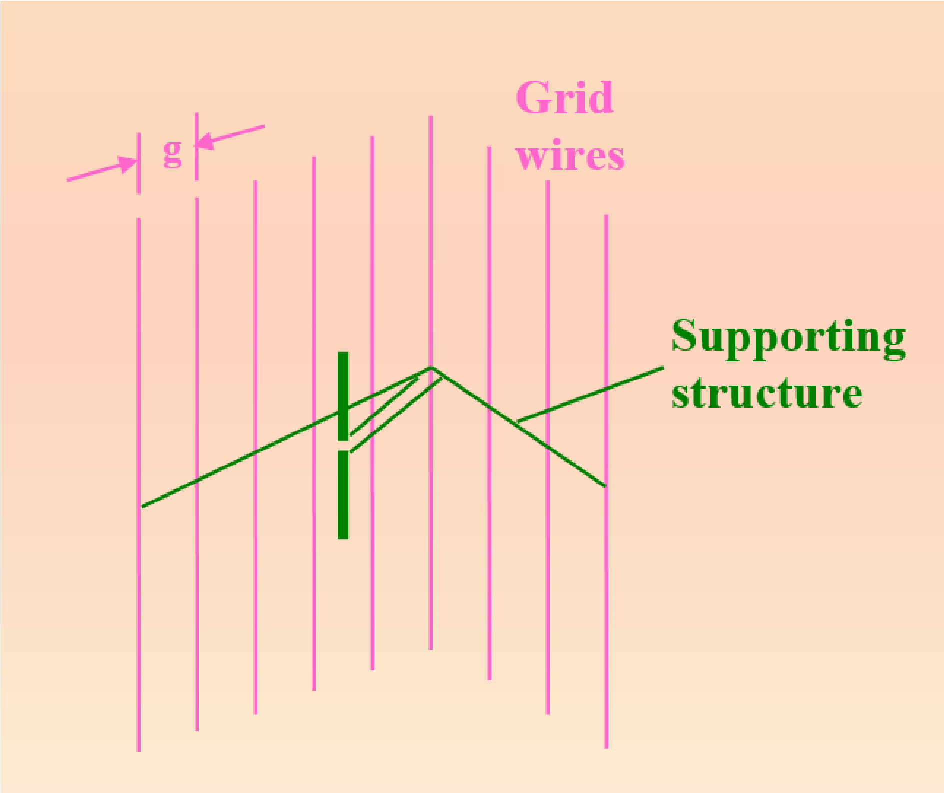


Wave incident at 90^0 Corner Reflector reflects back in the same direction

Corner Reflector Antenna

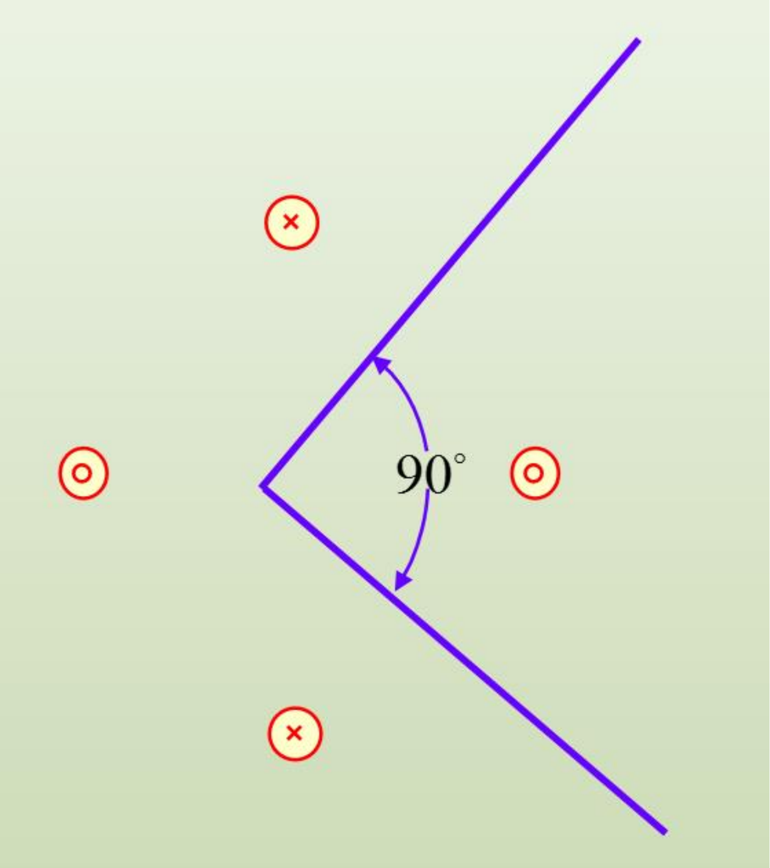


Prospective View

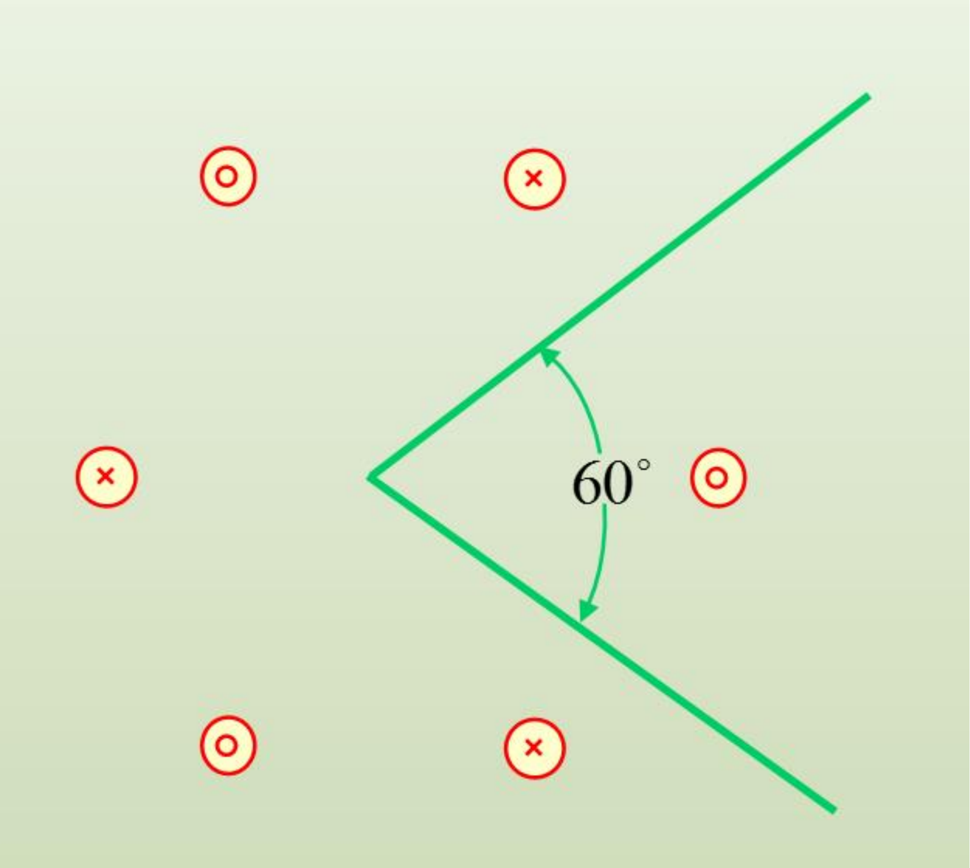


Wire Grid Arrangement

Images for Corner Reflector Antennas

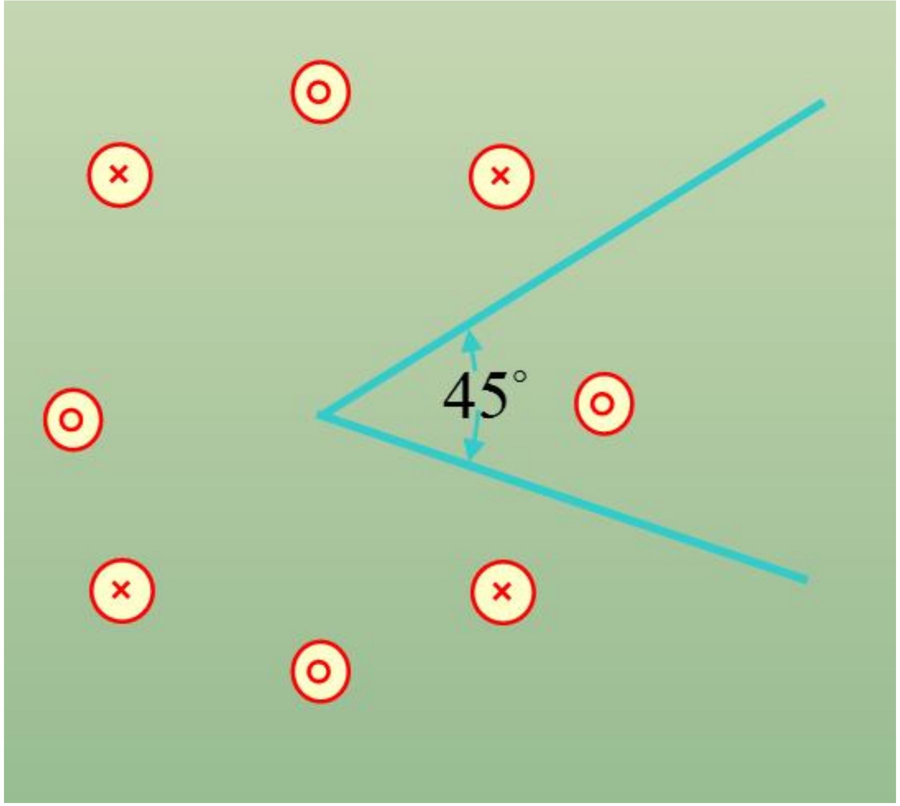


3 Images for 90^0 Corner Reflector Antenna

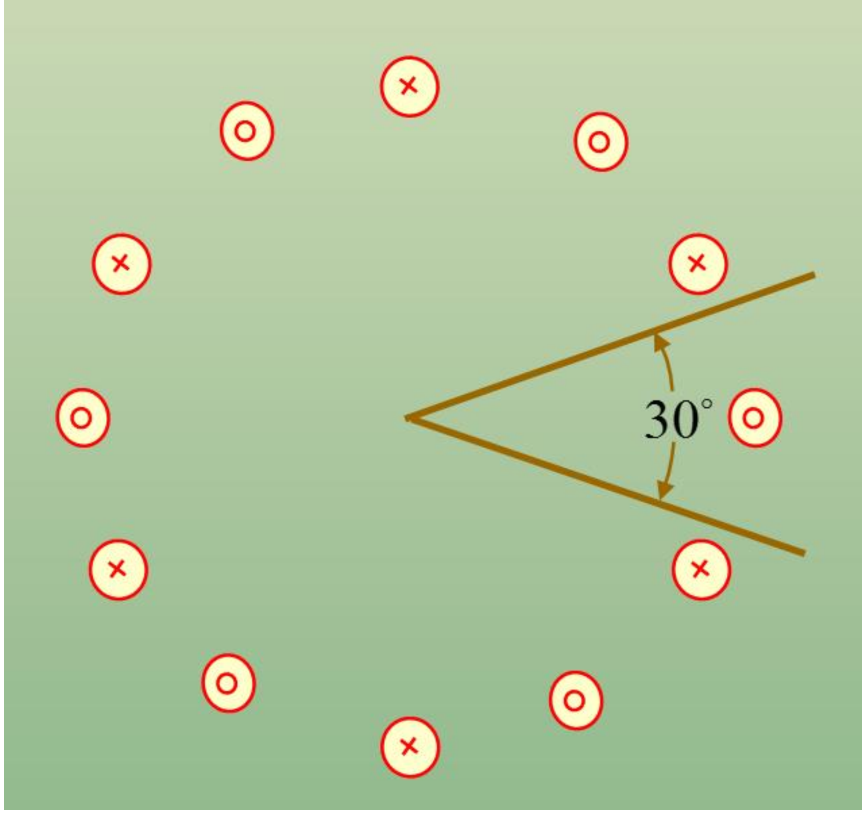


5 Images for 60^0 Corner Reflector Antenna

Images for Corner Reflector Antennas



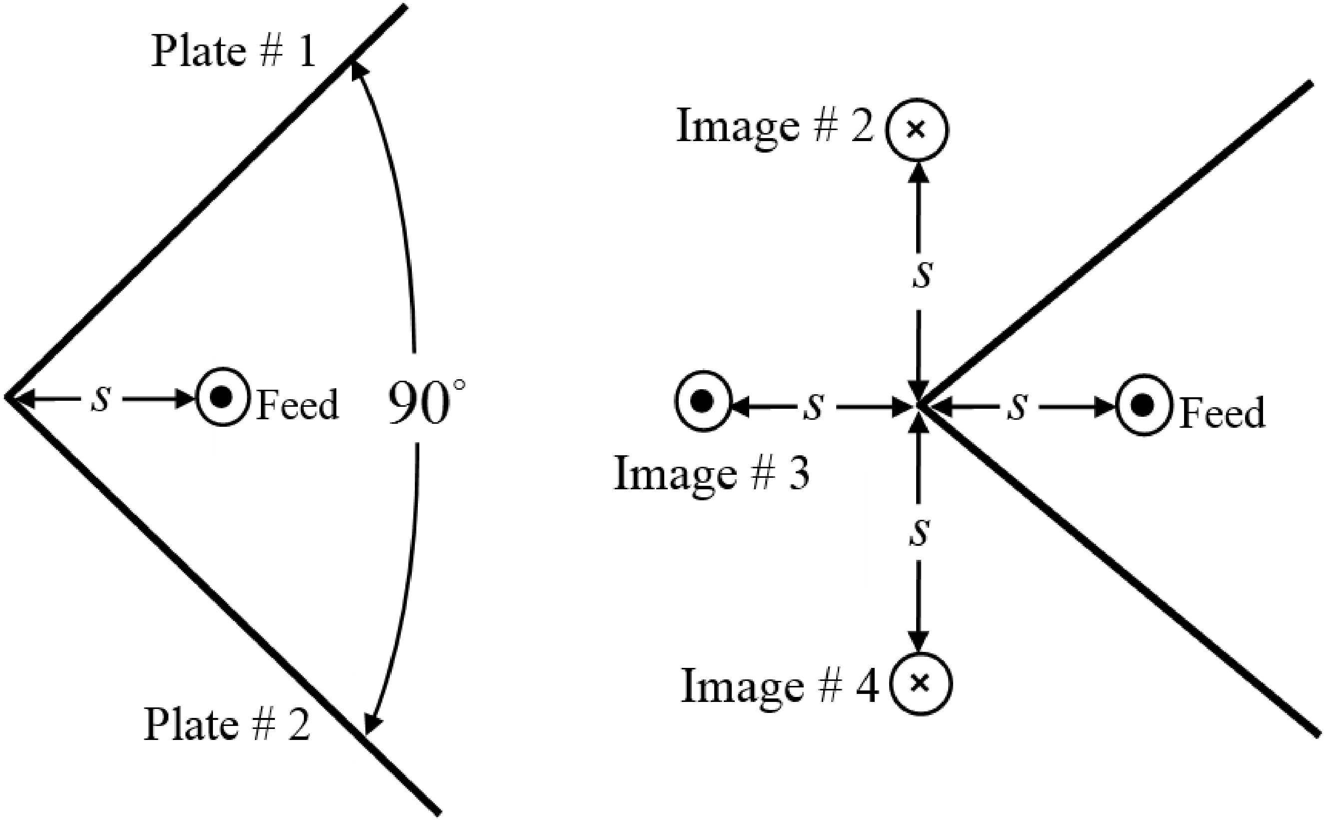
7 Images for 45^0 Corner Reflector Antenna



11 Images for 30^0 Corner Reflector Antenna

No. of Images = $360/\alpha - 1$

90° Corner Reflector Antenna



Total field will be sum of contributions from the feed and its images.

$$\boxed{E(r,\theta,\phi) = E_1(r_1,\theta,\phi) + E_2(r_2,\theta,\phi) + E_3(r_3,\theta,\phi) + E_4(r_4,\theta,\phi)}$$

Array Factor for *90°* Corner Reflector Antenna

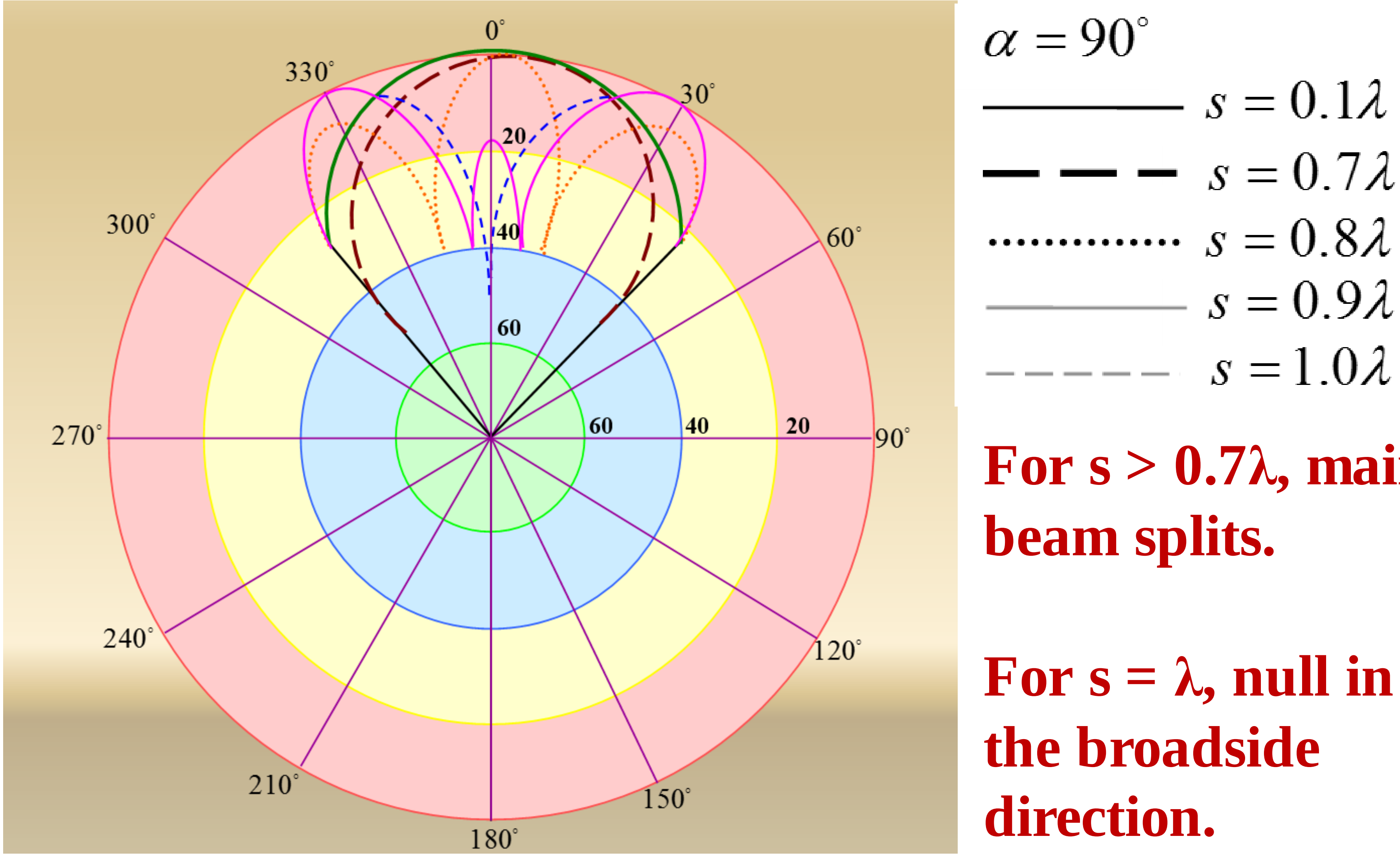
Array factor of the 90° Corner Reflector Antenna:

$$\boxed{\frac{E}{E_0} = AF(\theta,\phi) = 2\left[\cos\left(ks\sin\theta\cos\phi\right) - \cos\left(ks\sin\theta\sin\phi\right)\right]}$$

In the Azimuthal Plane, ($\theta = \pi/2$)

$$\boxed{\frac{E}{E_0} = AF(\theta = \pi/2,\phi) = 2\left[\cos\left(ks\cos\phi\right) - \cos\left(ks\sin\phi\right)\right]}$$

Radiation Pattern of 90^0 Corner Reflector Antenna



For s > 0.7λ, main beam splits.

For s = λ, null in the broadside direction.

Array Factor of Corner Reflector Antenna for other α

$$For \quad \alpha = 60^o$$

$$AF(\theta,\phi) = 4\sin\left(\frac{X}{2}\right)\left[\cos\left(\frac{X}{2}\right) - \cos\left(\sqrt{3}\frac{Y}{2}\right)\right]$$

$$For \quad \alpha = 45^o$$

$$AF(\theta,\phi) = 2\left[\cos(X) + \cos(Y) - 2\cos\left(\frac{X}{\sqrt{2}}\right)\cos\left(\frac{Y}{\sqrt{2}}\right)\right]$$

$$For \quad \alpha = 30^o$$

$$AF(\theta,\phi) = 2\left[\cos(X) - 2\cos\left(\frac{\sqrt{3}}{2}X\right)\cos\left(\frac{Y}{2}\right) - \cos(Y) + 2\cos\left(\frac{X}{2}\right)\cos\left(\frac{\sqrt{3}}{2}Y\right)\right]$$

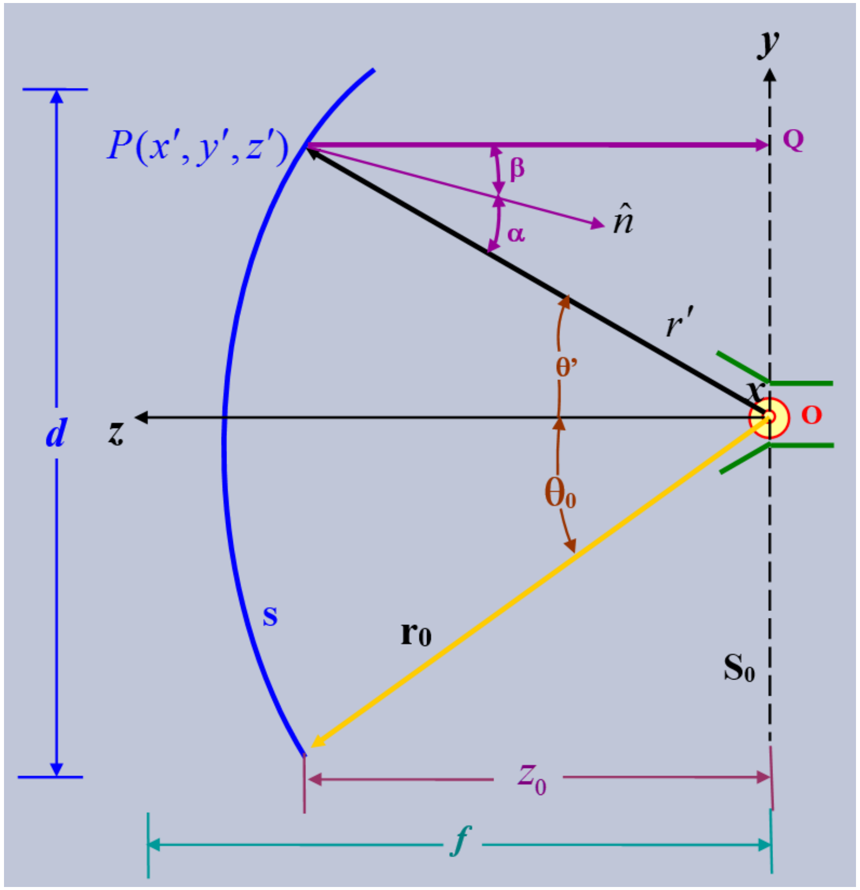
where $\boxed{X = ks\sin\theta\cos\phi}$ $\boxed{Y = ks\sin\theta\sin\phi}$

S-Limit for Corner Reflector Antennas

There is Limit on S-value for single lobe in the radiation pattern.

$S < 0.7\lambda$	$\alpha = 90^0$
$s < 0.95\lambda$	$\alpha = 60^\circ$
$s < 1.2\lambda$	$\alpha = 45^\circ$
$s < 2.5\lambda$	$\alpha = 30^\circ$

Parabolic Reflector Antenna



For Parabola:

OP + PQ = constant = 2f

OP = r' and PQ = r'cosθ'

So, r' (1+ cosθ') =2f

$$r' = \frac{2f}{1+\cos\theta'} = f\sec^2\left(\frac{\theta'}{2}\right) \quad \theta \le \theta_0$$

$$r' + r'\cos\theta' = \sqrt{(x')^2+(y')^2+(z')^2} + z' = 2f$$

$$\boxed{(x')^2 + (y')^2 = 4f(f - z') \quad \text{with } (x')^2 + (y')^2 \le (d/2)^2}$$

Parabolic Reflector Antenna Equations

$$\theta_0 = \tan^{-1}\left(\frac{d/2}{z_0}\right)$$

$$\theta_0 = \tan^{-1}\left|\frac{\frac{d}{2}}{f - \frac{d^2}{16f}}\right| = \tan^{-1}\left|\frac{\frac{1}{2}\left(\frac{f}{d}\right)}{\left(\frac{f}{d}\right)^2 - \frac{1}{16}}\right|$$

$$f = \left(\frac{d}{4}\right)\cot\left(\frac{\theta_0}{2}\right)$$

f/d	0.4	0.5	0.6	0.7	0.8	1.0
θ_0	64.0	53.1	45.2	39.3	34.7	28.1

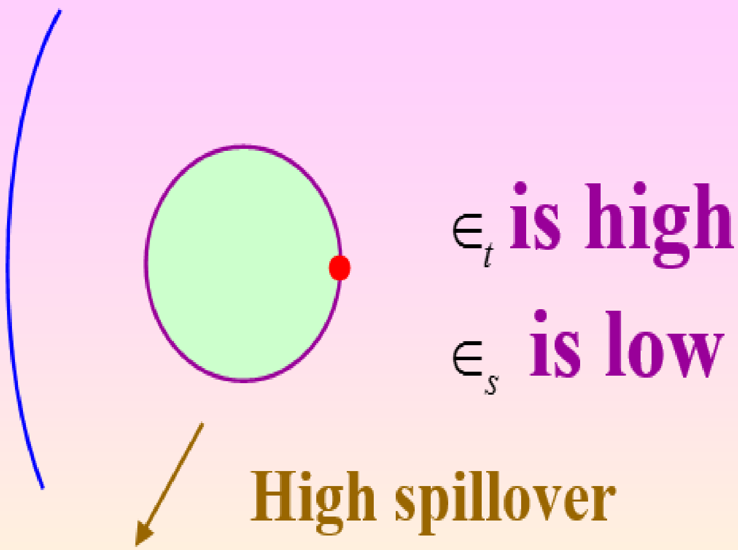
Gain and Aperture Efficiency of Parabolic Reflector Antenna

$$G = \varepsilon_{ap} D_u = \varepsilon_{ap} \frac{4\pi}{\lambda^2} A_p$$

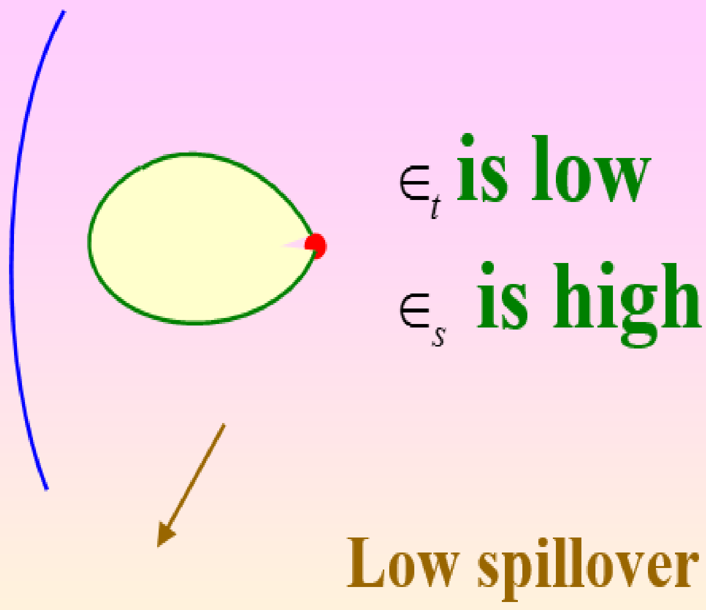
$$\in_{ap} = \in_s \in_t \in_p \in_x \in_b \in_r$$

- **Spillover efficiency** ($\in_s$): fraction of the total power that is radiated by the feed, intercepted, and collimated by the reflecting surface.
- **Taper efficiency** ($\in_t$) :uniformity of the amplitude distribution of the feed pattern over the surface of the reflector.
- **Phase efficiency** ($\in_p$): phase uniformity of the field over the aperture plane.
- **Polarisation efficiency** ($\in_x$) : polarization uniformity of the field over the aperture plane
- **Blockage efficiency** ($\in_b$)
- ***Random Error Efficiency*** ($\in_r$)

Effect of Feed Pattern on Efficiency

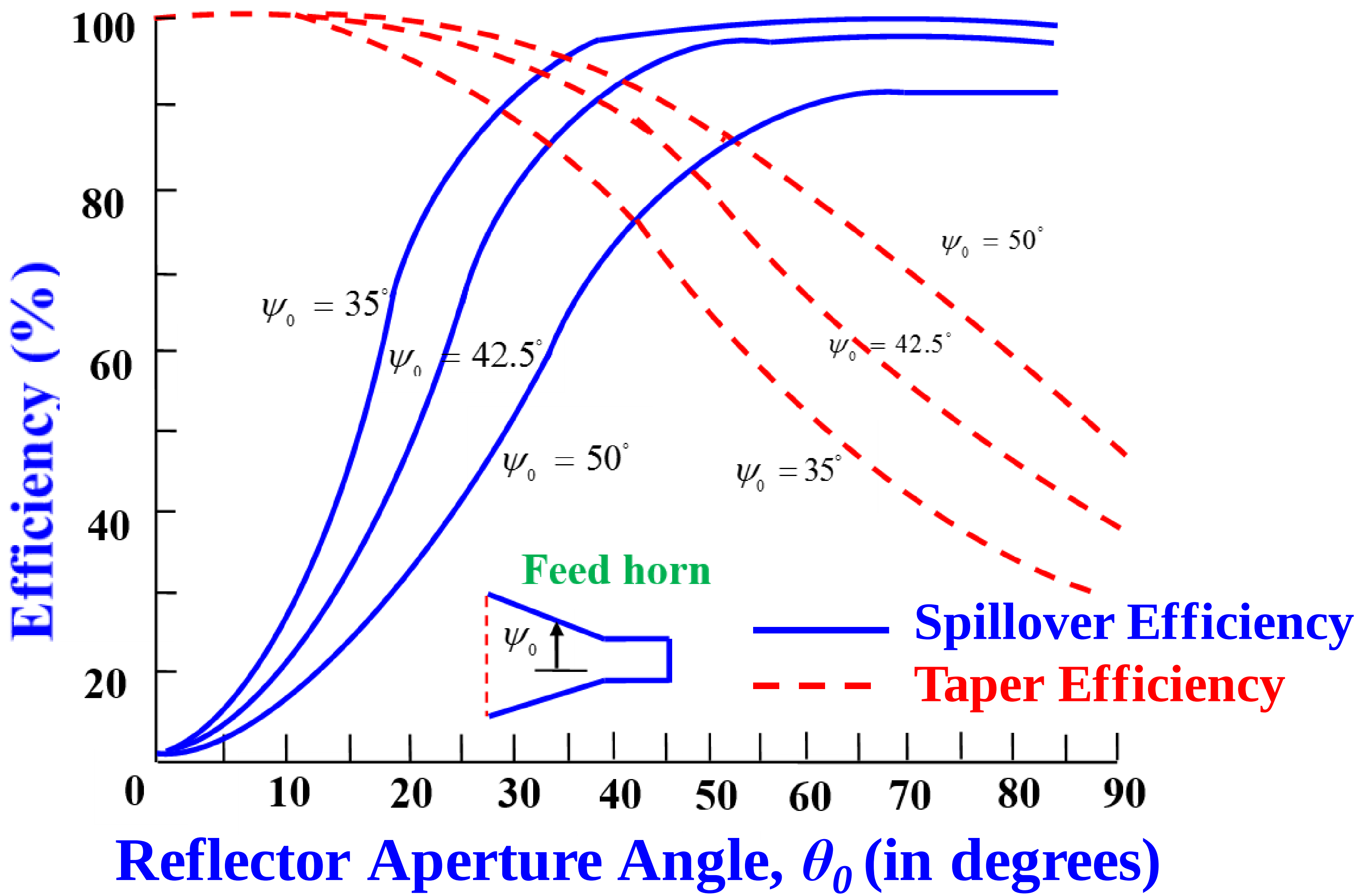


(a) Broad feed pattern giving high aperture taper efficiency but low spillover efficiency.

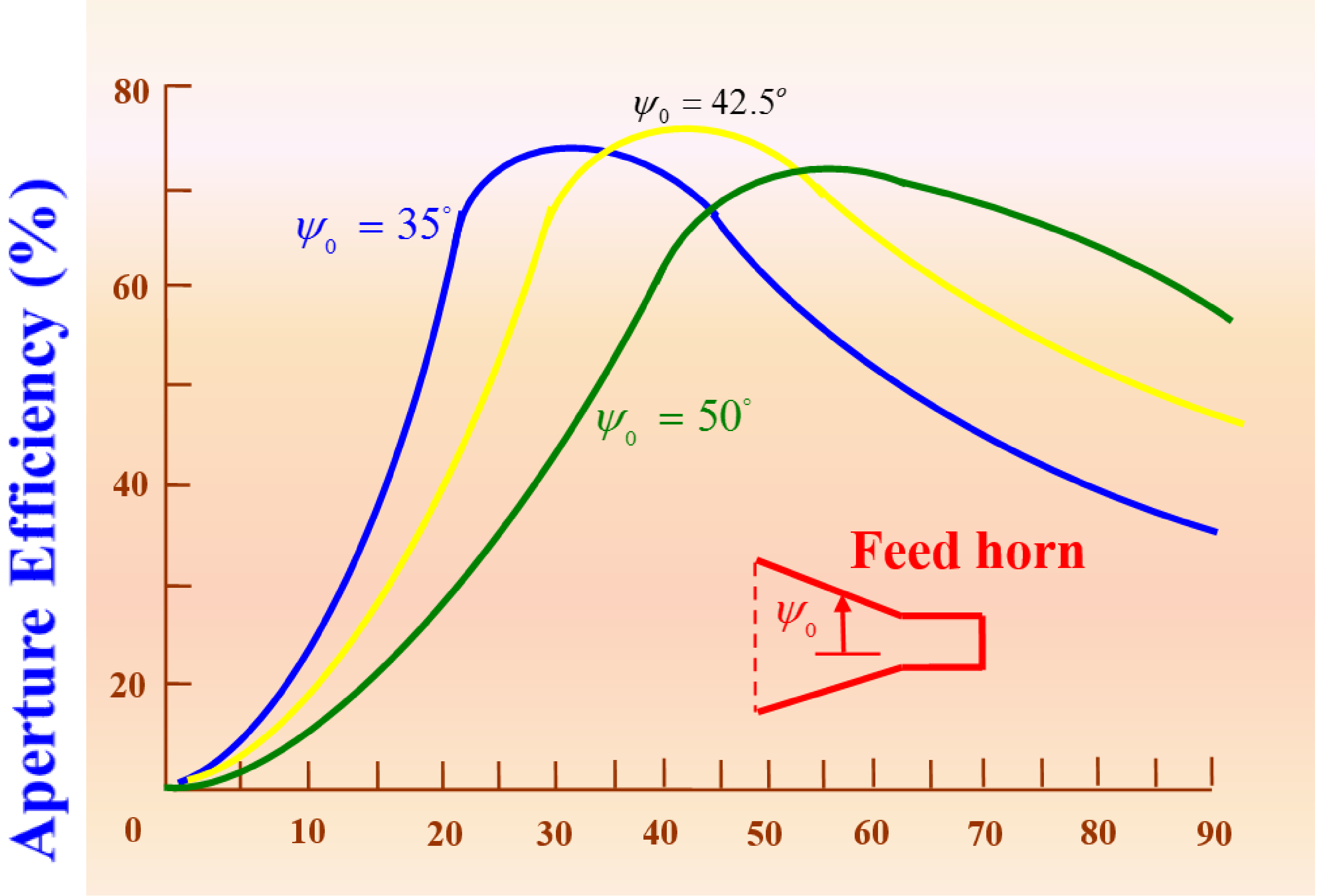


(b) Narrow feed pattern giving high spillover efficiency but low aperture taper efficiency.

Spillover and Taper Efficiencies of Parabolic Reflector Antenna

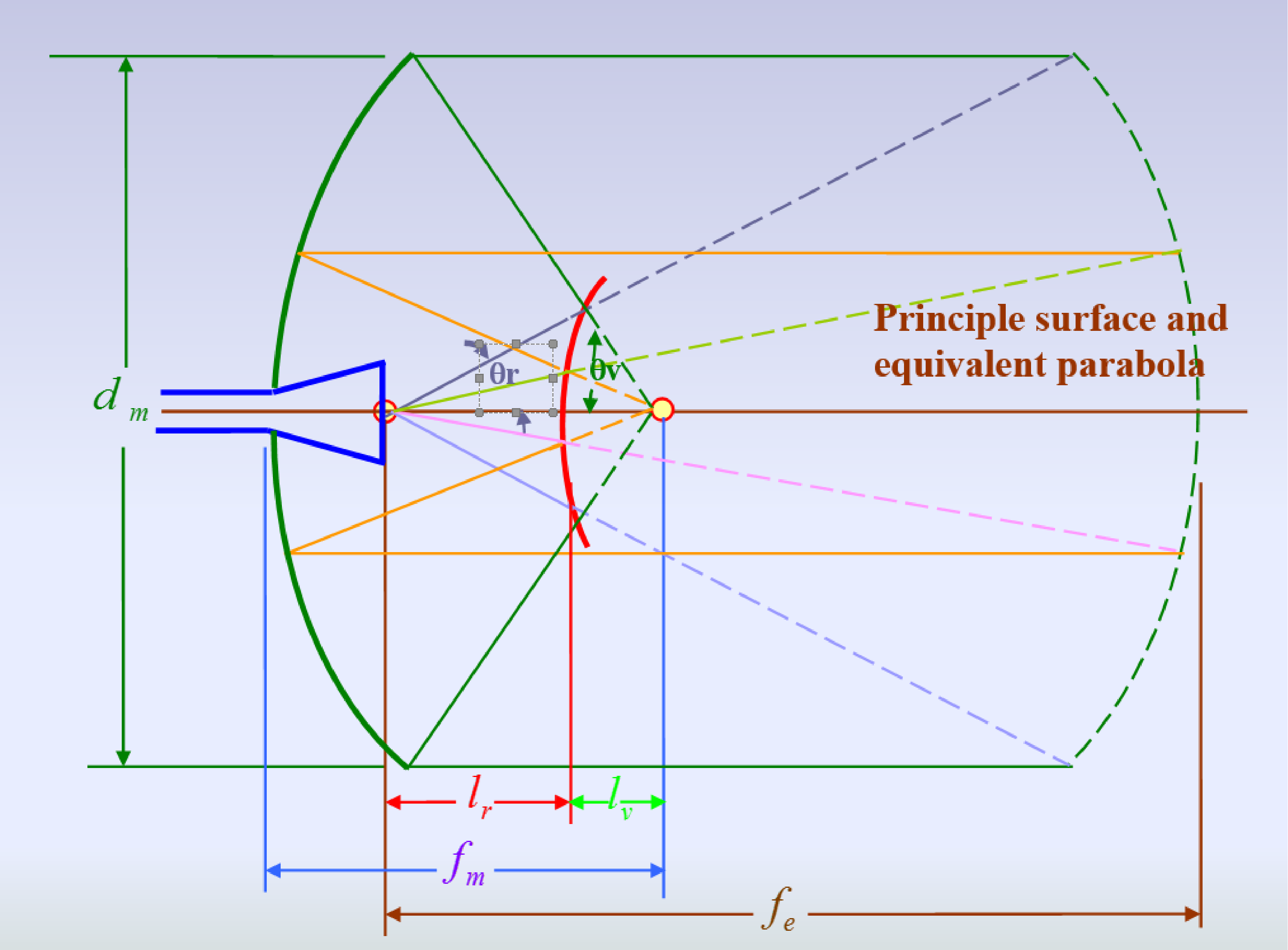


Aperture Efficiency of Parabolic Reflector Antenna



Reflector Aperture Angle, θ_0 (in degrees)

Cassegrain Reflector Antenna



Gain of Large Reflector Antennas