

Problem 9.29 An antenna with a circular aperture has a circular beam with a beamwidth of 3° at 20 GHz.

- (a) What is the antenna directivity in dB?
- (b) If the antenna area is doubled, what will be the new directivity and new beamwidth?
- (c) If the aperture is kept the same as in (a), but the frequency is doubled to 40 GHz, what will the directivity and beamwidth become then?

Solution:

- (a) From Eq. (9.96),

$$D \simeq \frac{4\pi}{\beta^2} = \frac{4\pi}{(3^\circ \times \pi/180^\circ)^2} = 4.59 \times 10^3 = 36.6 \text{ dB}.$$

(b) If area is doubled, it means the diameter is increased by $\sqrt{2}$, and therefore the beamwidth decreases by $\sqrt{2}$ to

$$\beta = \frac{3^\circ}{\sqrt{2}} = 2.2^\circ.$$

The directivity increases by a factor of 2, or 3 dB, to $D = 36.6 + 3 = 39.6 \text{ dB}$.

(c) If f is doubled, λ becomes half as long, which means that the diameter to wavelength ratio is twice as large. Consequently, the beamwidth is half as wide:

$$\beta = \frac{3^\circ}{2} = 1.5^\circ,$$

and D is four times as large, or 6 dB greater, $D = 36.6 + 6 = 42.6 \text{ dB}$.
