

9.34 Compare directivity D_{ant} of a 1 m diameter antenna aperture operating at 10 GHz with directivity D_{eye} of the eye's pupil operating in the middle of the visible spectrum at $\lambda = 0.5 \mu\text{m}$. Treat the pupil as a circular aperture with a diameter of 4 mm.

Solution: Using Eq. (9.91),

$$D_{\text{ant}} = \frac{4\pi A_{\text{ant}}}{\lambda_{\text{ant}}^2} = \frac{4\pi \times (\pi 0.5^2)}{(3 \times 10^{-2})^2} = 1096.6,$$
$$D_{\text{eye}} = \frac{4\pi A_{\text{pupil}}}{\lambda_{\text{vis}}^2} = \frac{4\pi \times (\pi (2 \times 10^{-3})^2)}{(0.5 \times 10^{-6})^2} = 6.32 \times 10^8.$$

Hence,

$$\frac{D_{\text{eye}}}{D_{\text{ant}}} = \frac{6.32 \times 10^8}{1.0966 \times 10^3} = 5.76 \times 10^5 !!$$

The eye at $\lambda = 0.5 \mu\text{m}$ is close to a million times more directive than the 1 m diameter antenna at 10 GHz.
