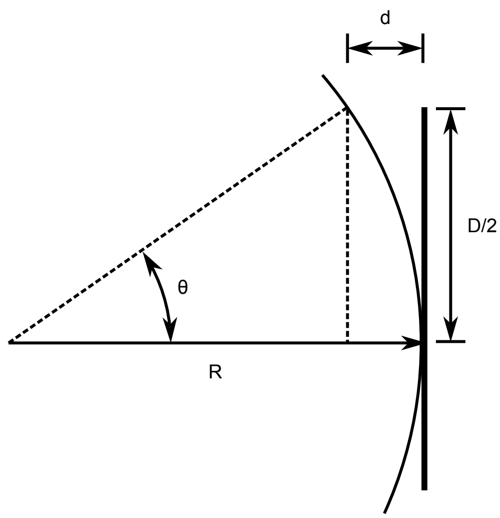
1) Consider a spherical wave emitted from a "point" antenna. For the "far-field", it is desired that the wave be "planar" over an aperature of width D at range R. The far-field criterion is that the wave front deviate no more than $\lambda/16$ from a plane (the Fraunhofer criterion); show that $R(\text{far-field}) = 2D^2/\lambda$.

The following solution depends on the small angle approximation:

$$x = r\left(1 - \frac{\theta^2}{2}\right) \qquad \text{and} \qquad y = r\theta.$$

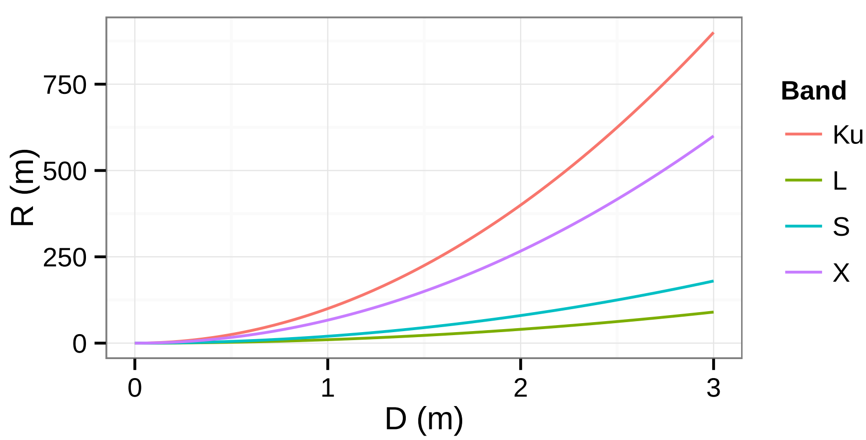


$$\begin{aligned} y &= R\theta|_{y=\frac{D}{2}} \rightarrow \theta = \frac{D}{2R} \\ \therefore x &= R\left(1 - \frac{\left(\frac{D}{2R}\right)^2}{2}\right) \\ d &= R - x \\ &= R - R\left(1 - \frac{\left(\frac{D}{2R}\right)^2}{2}\right) \\ \therefore R &= \frac{D^2}{8d} \end{aligned}$$

Evaluating the final equation for R with the substitution that $d = \frac{\lambda}{16}$ yields the final relationship for the far-field threshold range:

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

2) Calculate the near/far-field "boundary" ($R = 2D^2/\lambda$), for $D = 1$m, at L, S, X, Ku, and Ka bands.



The threshold range for the far field for $D = 1$m for the L band, S Band, X Band, and Ku Band is 10.00 m, 20.00 m, 66.67 m, 100.00 m, respectively.

3) Using your computer, choose of the aperature antenna patterns discussed, and produce a 3D plot of it.

I have choosen to replicate the 20λ x 10λ rectangular plane aperature presented in the slides. The exact formula that I used is the following:

$$f(u, v) = \text{sinc}\left(\frac{kL_x u}{2}\right) \text{sinc}\left(\frac{kL_y v}{2}\right)$$