2.100 Repeat Problem 2.99 for two antennas with 30 dB directivities and separated by 100λ. The power at the input terminals is 20 W.

2.99 Two lossless, polarization-matched antennas are aligned for maximum radiation between them, and are separated by a distance of 50λ. The antennas are matched to their transmission lines and have directivities of 20 dB. Assuming that the power at the input terminals of the transmitting antenna is 10 W, find the power at the terminals of the receiving antenna.

Ant #1 Ant #2

$P_t = 20\,W$ ⟵ $R = 100\lambda$ ⟶ $P_r = ?$

$D_{max,1} = 30\,dB$ $D_{max,2} = 30\,dB$

Use Friis Transmission Eq'n (2-118)

$$\frac{P_r}{P_t} = e_{cdt}\, e_{cdr} (1-|\Gamma_t|^2)(1-|\Gamma_r|^2)\left(\frac{\lambda}{4\pi R}\right)^2 D_t D_r |\hat{p}_t \cdot \hat{p}_r|^2$$

"lossless" $\Rightarrow e_{cdt} = e_{cdr} = 1$

"polarization-matched" $\Rightarrow PLF = |\hat{p}_t \cdot \hat{p}_r|^2 = 1$

"matched ... transmission lines" $\Rightarrow |\Gamma_t| = |\Gamma_r| = 0$

$D_t = D_r = 10^{30/10} = 10^3 = 1000$

$$P_r = (20\,W)(1)(1)(1-0)(1-0)\left(\frac{\lambda}{4\pi\, 100\lambda}\right)^2 1000\,(1000)\,1$$

$$\underline{\underline{P_r = 12.665\ W}}$$