

26. We denote the Earth-Moon separation as L . The energy of the beam of light which is projected onto the moon is concentrated in a circular spot of diameter d_1 , where $d_1/L = 2\theta_R = 2(1.22\lambda/d_0)$, with d_0 the diameter of the mirror on Earth. The fraction of energy picked up by the reflector of diameter d_2 on the Moon is then $\eta' = (d_2/d_1)^2$. This reflected light, upon reaching the Earth, has a circular cross section of diameter d_3 satisfying $d_3/L = 2\theta_R = 2(1.22\lambda/d_2)$. The fraction of the reflected energy that is picked up by the telescope is then $\eta'' = (d_0/d_3)^2$. Consequently, the fraction of the original energy picked up by the detector is

$$\begin{aligned} \eta &= \eta' \eta'' = \left(\frac{d_0}{d_3}\right)^2 \left(\frac{d_2}{d_1}\right)^2 = \left[\frac{d_0 d_2}{(2.44\lambda d_{em}/d_0)(2.44\lambda d_{em}/d_2)}\right]^2 = \left(\frac{d_0 d_2}{2.44\lambda d_{em}}\right)^4 \\ &= \left[\frac{(2.6 \text{ m})(0.10 \text{ m})}{2.44(0.69 \times 10^{-6} \text{ m})(3.82 \times 10^8 \text{ m})}\right]^4 \approx 4 \times 10^{-13} . \end{aligned}$$