14. Two stars are 3.7 x 10^{11} m apart and are equally distant from the earth. A telescope has an objective lens with a diameter of 1.02 m and just detects these stars as separate objects. Assume that light of wavelength 550 nm is being observed. Also assume that diffraction effects, rather than atmospheric turbulence, limit the resolving power of the telescope. Find the maximum distance that these stars could be from the earth.

When two objects are "just resolved" their central diffraction maximum of each object lies on the first diffraction minimum of the other object and this leads to the minimum angle of resolving for circular apertures is

$$\theta_{minimum} = \frac{1.22\,\lambda}{D}$$

Now since the stars are far from Earth, we are dealing with small angles so the following approximation applies

$$\sin(\theta) \approx \tan(\theta) \approx \theta$$

So we can find tangent from

$$\tan(\theta) = \frac{s}{L} \approx \theta = \frac{1.22\,\lambda}{D}$$

Solve for distance from Earth, L.

$$L = \frac{sD}{1.22\,\lambda} = \frac{(3.7\ x\ 10^{11} m)(1.02\ m)}{1.22(550\ x\ 10^{-9}\ m)} = 5.62\ x\ 10^{17} m$$

$$\boxed{L = 5.62\ x\ 10^{17} m}$$

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