

ASTR469: Problem Solving Day #3.

In this exercise you will compare the performance and properties of two telescopes.

Telescope	White Hall Rooftop	Green Bank Telescope
Lat, lon	39.6° N, 80.0° W	38.4° N, 79.8° W
Primary aperture diameter	$14'' = 35.56 \text{ cm}$	100 m
Observing band range	300 nm to ~1000 nm	100 MHz to 115 GHz
Primary f-number	$f/2$ ($N = 2$)	$f/0.6$ ($N = 0.6$)
Telescope design type	Schmidt-Cassegrain	Off-axis Gregorian
Electromagnetic band?	<i>Optical</i>	<i>Radio</i>
Primary aperture collecting area	0.4 m^2	7854 m^2
Primary aperture focal length (m)	0.71 m	60 m
Smallest resolvable angle (arcmin)	$0.003'$	$0.089'$
Smallest resolvable size at 3 Gpc ($z \approx 1$) (pc)	2500 pc	78000 pc
Reflector surface accuracy requirement (mm)	$3 \times 10^{-6} \text{ mm}$	0.26 mm

Both circular primary aperture, $A = \pi r^2$
 $N = \frac{f}{D}$
 $\theta = \frac{\lambda_{\min}}{D}$ (rad)
 See below
 → 10% of shortest λ

Smallest resolvable θ

$\lambda \rightarrow$ shortest observing wavelength.
 $\theta = \frac{\lambda}{D} \rightarrow$ aperture diameter

Rooftop

$\lambda = 3 \times 10^{-7} \text{ m}$
 $D = 0.3556 \text{ m}$
 $\theta_{\text{res}} = \frac{\lambda}{D} = 8.4 \times 10^{-7} \text{ rad}$
 $\times \frac{180 \text{ deg}}{\pi \text{ rad}} \times \frac{60'}{1 \text{ deg}}$
 $= 0.003'$
 (0.2'')

GBT

$\lambda_{\min} = \frac{c}{\nu_{\max}} = \frac{c}{115 \text{ GHz}} = 2.6 \times 10^{-3} \text{ m}$
 $D = 100 \text{ m}$
 $\theta_{\text{res}} = \frac{2.6 \times 10^{-3} \text{ m}}{100 \text{ m}} = 2.6 \times 10^{-5} \text{ rad}$
 $= 0.089'$
 (5.4'')

Smallest Res. Scale

