1.)

$$\theta = \frac{1.22\lambda}{D} \text{ [rad]}$$

D ~ aperture diameter.

arc sec → rad $\left(\frac{1^\circ}{3600''} \cdot \frac{\pi}{180^\circ} \right)$

$$\Rightarrow \theta = 0.7 \left(\frac{0.55\,\mu m}{\lambda} \right)^{0.2} \text{[arcsec]} = \frac{1.22\lambda}{D} \text{ [rad]}$$

$$\Rightarrow 0.7 \left(\frac{0.55\,\mu m}{\lambda} \right)^{0.2} \cdot \frac{1^\circ}{3600} \cdot \frac{\pi}{180^\circ} = \frac{1.22\lambda}{D}$$

★ approximation

$$\Rightarrow \frac{0.7D}{1.22} \left(0.55\,\mu m \right)^{0.2} \cdot \frac{1^\circ}{3600} \cdot \frac{\pi}{180^\circ} = \lambda \cdot \lambda^{0.2} \Rightarrow \underline{1 + 0.2 \sim 6/5}$$

$$\Rightarrow \left(\frac{0.7D}{1.22} \left(0.55\,\mu m \right)^{0.2} \frac{1^\circ}{3600} \cdot \frac{\pi}{180^\circ} \right)^{5/6} \Rightarrow \lambda \sim \left(2.47 \cdot 10^{-6} D \right)^{5/6}$$

$$\sim 2.12 \times 10^{-5} D^{5/6} \text{ [}\mu m\text{]}$$

For 8-m telescope :

$$2.12 \times 10^{-5} \left(8 \cdot 10^{6}\,\mu m \right)^{5/6} \boxed{12\,\mu m} \#$$

For 1-m telescope :

$$\boxed{2.12\,\mu m} \#$$

2) $R_B = 16$ counts / sec, $R_S = R_B/100$ (1% of background).

$N = M - S - B$

$$\boxed{SNR} = \frac{\bar{S}}{\sigma_N} = \frac{R_S \Delta T}{\sqrt{2(R_S+R_B)\Delta T}} = \frac{R_S}{\sqrt{2(R_S+R_B)}}\sqrt{\Delta T} = \boxed{2}$$

$\Rightarrow \sigma_N$

$$\Rightarrow \boxed{\Delta T = \frac{(2R_S)^{-2}}{2(R_S+R_B)^{-1}}}$$

$$P(k;\lambda) = \frac{\lambda^k e^{-\lambda}}{k!}, \quad \lambda = rt$$

$$\sigma_N = \sqrt{\sigma_M^2 + \sigma_S^2 + \sigma_B^2}$$

$$\bar{M} = \bar{S} + \bar{B} = R_S \Delta T + R_B \Delta T = (R_S + R_B)\Delta T$$

$$\Delta T = 4\,\frac{2(R_S+R_B)}{R_S^2} = 8\left(\frac{1}{R_S} + \frac{R_B}{R_S^2}\right) = 8\left(\frac{10^2}{R_B} + \frac{10^4 \cancel{R_B}}{\cancel{R_B}^2}\right)$$

$$= 8\left(\frac{10^2}{R_B} + \frac{10^4}{R_B}\right) \sim \frac{8\cdot 10^4}{R_B} = \frac{8\cdot 10^4}{16} = 0.5 \times 10^4 = \boxed{5000\text{ sec.}}$$

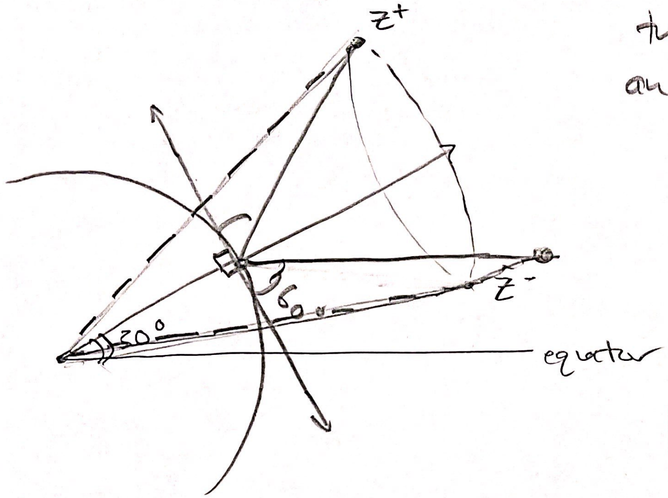
3) Aries $\rightarrow$ $RA(\gamma) = 0^h 0^m 0^s$ $Dec(\gamma) = 0°$

$\Rightarrow$ $LST = RA + HA$ $\Rightarrow$ $LST = HA \simeq \boxed{0^h = LST}$ (good ref. point)

when on the meridian, $HA = 0$.

However, $RA(\gamma) = 0^h 0^m 0^s$ $\Rightarrow$ $LST = 0$.

4.7



two possible locations for an object z:

crosses meridian @ alt. +60°

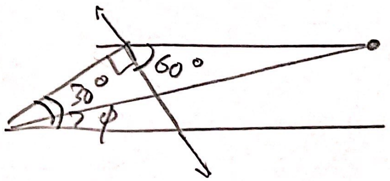
LST = +5^h, LST = ~~HA~~ + RA

LST = RA = +5^h

thus, RA : Dec :

$\boxed{(+5^h : 60^\circ) \text{ or } (+5^h : 0^\circ)}$

?



$90^\circ + 60^\circ$, $30^\circ - \text{Dec}^\circ$, Dec° ⇒

$180^\circ = 90^\circ + 60^\circ + 30^\circ - \phi^\circ + D^\circ$ Dead End.

sin(altitude) = s(Dec) · sin(latitude)

⇒ sin(alt) = cos(dec − lat)

⇒ Dec − lat = cos^{-1}(sin(alt))

or 0° ??

⇒ $\boxed{\text{Dec} = 60^\circ = 30^\circ + 30^\circ}$

5) Dec ~ lat. = 37° June 9, 2021. 10 pm.

M13 Hercules Cluster RA 16:41.7 Dec 36°28'

SFA star chart 3 - Equatorial region

→ In range of June 9, 2021 ; 8pm ⇒ ~13.25 h + 2h

→ $\boxed{15.25 h}$ for 10pm overhead → $\boxed{37° \text{ Dec.}}$

Hercules is probably best / closest Let from the catalogue. (Rich in spiral galaxies! ~200 galaxy cluster).

Also, $\boxed{\text{Ring nebula}}$: Lyra, RA (18:53.6) Dec (33°02')

a planetary nebula, looks gorgeous! formed by a star burst.

6.) $L^* = 100 L_\odot \Rightarrow M_{bol}^* = 9.8$ $\quad M_{bol\odot} = 4.8$, what is D?

$$m_\odot = -2.5 \log\left(\frac{L_\odot}{4\pi d_\odot^2}\right) + \text{const}$$ ~ calibration $c(\lambda)$

$$m' = -2.5 \log\left(\frac{L'}{4\pi d'^2}\right) + c(\lambda)$$ comparing both:

$$m_\odot - m' = -2.5 \log\left(\frac{L_\odot}{4\pi d_\odot^2}\right) + 2.5 \log\left(\frac{L'}{4\pi d'^2}\right)$$

$$= 2.5 \log\left(\frac{L'}{\cancel{4\pi} d'^2} \cdot \frac{\cancel{4\pi} d_\odot^2}{L_\odot}\right) = 2.5 \log\left(\frac{d_\odot^2 100 \cancel{L_\odot}}{d'^2 \cancel{L_\odot}}\right) = m_\odot - m'$$

dist. $\boxed{= 1\text{kpc}}$ #

$\boxed{d' = D,\ d_\odot = 10\text{ pc} \neq 1\text{ au}}$ ☆

7.) $T_{eff\odot}$ $\rightarrow$ $L = \sigma R^2 T_{eff}^4$ $\Rightarrow$ $L' = \sigma R'^2 T_{eff}^4$

vs. $L_\odot = \sigma R_\odot^2 T_{eff}^4$

$$\frac{L'}{L_\odot} = \frac{\sigma R'^2 T_{eff}^4}{\sigma R_\odot^2 T_{eff}^4} = \frac{R'^2}{R_\odot^2} \approx 10^4$$

s.t. this ratio, $R' = R_\odot \sqrt{10^4}$

$$\boxed{R' \sim 100 R_\odot}$$