Assignment-IV

November 12, 2021

Name: Samit Kumar Pal
Roll NO: 2101121008
Course Code: AA 605
DAASE,IITI

Assignment - 4

1) RA = 05h 55m 10.3 $= 5 + \frac{55}{60} + \frac{10.3}{3600} = 5.92$ hrs
$= 5.92 \times 15$
$= 88.8$ deg

DEC = 07° 24' 25'' $= 7 + \frac{24}{60} + \frac{25}{3600} = 7.41$ deg $= \delta$

Time = 9 PM (IST) = 3:30 pm (UT) = 15:30
$= 15 + \frac{30}{60}$
$= 15.5$ hrs.

LAT = 22.72 deg = ϕ

LONG = 77.8 deg.

LST = 23.25 hrs = 23.25×15 deg = 348.75 deg

So, HA = LST − RA = (348.75 − 88.8) deg
= 259.95 deg = H

we know that,

$$\sin h = \sin\phi \sin\delta + \cos\phi \cos\delta \cos H$$

$$\Rightarrow \sin h = \sin(22.72)\sin(7.41) + \cos(22.72)\cos(7.41) \times \cos(259.95)$$

$$\sin h = -0.1098$$

$$\Rightarrow h = \sin^{-1}(-\cancel{0.09}\,0.1098) = -6.304 \text{ deg.}$$

$\Rightarrow$ Altitude (h) = 83.696° above.

Also, $\cos h \sin A = -\cos\delta \sin H$

$$\Rightarrow \sin A = -\frac{\cos(7.41) \times \sin(259.95)}{\cos(-6.304)}$$

$\Rightarrow A = \sin^{-1}(0.9824)$ = Azimuth

$\Rightarrow A = 79.23°$

2) Here, latitude $= \phi$ and longitude $= \lambda$

a) if the observer is ~~on~~ in the Northern Hemisphere, altitude of the celestial pole –

i) North celestial pole : ϕ

ii) South " " : $-\phi$

b) If the observer is in the Southern Hemisphere, altitude of the celestial pole –

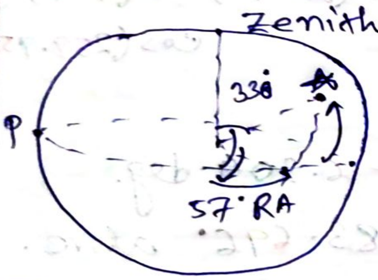
i) North celestial pole : $-\phi$

ii) South " " : ϕ

c) If the observer is in both of the Hemisphere, altitude of celestial equator :

i) Altitude : $90° - \phi$

All of the values are indepent on longitude λ.

3) 

Angular separation of γ crucis from zenith $= 33°$

So, At 33° latitude, it will be visible.

The star ~~57°~~ is 57° below the northern horizon. So, the latitude is 57° S.

In order ~~to~~ ~~for~~ star not to set, it has to be at P. so, latitude has to be $-33°$ or 33° S.

1(a) we know that,

$$\Delta m = -2.5 \log_{10}\left(\frac{b_1}{b_2}\right)$$

Here, $b_1 = 10^6 b_2$,

$\therefore m_1 - m_2 = \Delta m = -2.5 \log_{10}(10^6) = -2.5 \times 6$
$= -15$

$\Rightarrow m_1 = m_2 - 15$

b) $\Delta m = m_1 - m_2 = -2.5 \log_{10}\left(\frac{b_1}{b_2}\right)$

Now, $m_1 = 21$, $m_2 \simeq 0$

So, $21 = -2.5 \log_{10}\left(\frac{b_1}{b_2}\right) \Rightarrow \left(\frac{b_1}{b_2}\right) = 10^{-21/2.5}$
$= 3.98 \times 10^{-9}$

for HST, $m_1 = 28$, $\frac{b_1}{b_2} = 10^{-\frac{28}{2.5}} = 6.31 \times 10^{-12}$

c) $m_1 - m_2 = -2.5 \log_{10}\left(\frac{b_1}{b_2}\right)$.

Here, $m_1 = -1.44$

$\therefore -1.44 - m_2 = -2.5 \log_{10}\left(\frac{L/(8.8)^2}{L/(2.5\times10^6)^2}\right)$

$= -2.5 \log_{10}\left(\frac{2.5\times10^6}{8.8}\right)^2$

$= -5 \log_{10}\left(\frac{25}{88}\times10^6\right)$

$\Rightarrow -1.44 - m_2 = \cancel{-28} - 27.27$

$\Rightarrow m_2 = 27.27 - 1.44 = 25.83$

For HST, $m_r = 28$, so, it will be visible.

4d) Distance to the sun $= 1.5 \times 10^{-05}$ Ly

$M_V = 4.82$

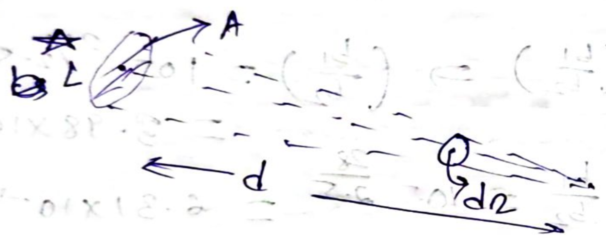
$\therefore 4.82 - m_2 = -5\log_{10}\left(\frac{2.5\times10^{6}}{1.5\times10^{-05}}\right)$

$\Rightarrow 4.82 - m_2 = -56.11$

$\Rightarrow m_2 = 4.82 + 56.11 = 60.93$

For HST, it will not visible.

5a)



For a source with luminosity L at a distance d, the flux is ~~received~~ given by —

$$f = \frac{L}{4\pi d^2}$$

If the ~~the~~ projected area is of source A, then the subtended solid angle $d\Omega = \frac{A}{d^2}$.

Specific intensity i.e. flux per unit solid angle

$$I = \frac{f}{d\Omega} = \frac{L d^2}{4\pi d^2 A} = \frac{L}{4\pi A}$$

$\therefore$ I is independent of d (distance.)

$\therefore$ The specifice intensity is distance independent

5b) We know that, $\Delta m = -2.5 \log_{10}\left(\frac{b_1}{b_2}\right)$

$$\frac{b_1}{b_2} = 10^{-\Delta m/2.5} \Rightarrow \frac{b_2}{b_1} = 10^{\Delta m/2.5}$$

$$f = \frac{n}{tA} \Rightarrow b_2 = b_1 10^{0.4\Delta m}$$

we know, absolute magnitude is equal to the appent magnitude that the object would have if it were viewed from a distance of 10 pc without dimming

if N stars are there in the patch.

$$\frac{NL}{4\pi d^2} = \frac{L}{4\pi(10pc)^2} \cdot 10^{0.4(M-I_0)}$$

$$\Rightarrow \boxed{N = \left(\frac{d}{10\,pc}\right)^2 \times 10^{0.4(M-I_0)}}$$

7) we know that,

$$m - M = 5\log\left(\frac{d}{10}\right)$$

$$\Rightarrow d = 10^{(m-M)/5} \times 10$$

$$d = 10^{(13+4)/5} \times 10$$

$$d = 10^{\frac{17}{5}+1}$$

$$\Rightarrow d = 10^{4.4}\ pc = 25.11 \times 10^{3}\ pc.$$

$$\Rightarrow d = 25.11\ kpc.$$

8) For 1st order, $n = 1$

we know that,

$$d\sin\theta = n\lambda$$

Diff w.r.t. λ,

$$d\cos\theta \frac{d\theta}{d\lambda} = n$$

$$\Rightarrow \frac{d\theta}{d\lambda} = \frac{n}{d\cos\theta}$$

$$\therefore \frac{dx}{d\lambda} = \frac{dx}{d\theta}\frac{d\theta}{d\lambda} = f_2 \frac{d\theta}{d\lambda}$$

$$\therefore \frac{d\lambda}{dx} = \frac{d\cos\theta}{nf_2}$$

$$\therefore d = \frac{nf_2}{\cos\theta}\frac{d\lambda}{dx} = \frac{20 \times 1 \times 300}{\cos(15^\circ)}\ A^\circ$$

$$= 6212\ A^\circ = 6.212 \times 10^{-7}\ m$$

$$Nd = 10^{-3} \Rightarrow N = \frac{10^{-3}}{6.212 \times 10^{-7}} = 1610\ \text{lines/mm}.$$

6(a) ~~Here~~, $m_{r} = 22 = m$

For reference, we ~~take~~ $m_2 = m_{sun} = 4.82$

we know that,

$$\Delta m = -2.5 \log_{10}\left(\frac{b_1}{b_2}\right)$$

$$\Rightarrow 22 - 4.82 = -2.5 \log_{10}(b/s)$$

for solar flux, $s = 1370\ W/m^2$

$$b = \cancel{1370 \times 10^{-\frac{17.82}{2.5}}}\ W/m^2$$

$$b = 1370 \times 10^{-17.18/2.5}\ W/m^2 = 1.83 \times 10^{-4}\ W/m^2$$

for frequency width Δf, $b = b_f \Delta f$, $b_f \rightarrow$ Specific flux

In V- band, $\Delta f = 35 \times 10^9$ Hz

so, $b_f = F_\nu$

$$\therefore \; b_f = \frac{b}{\Delta f} = \frac{1.83 \times 10^{-4}}{35 \times 10^9} = 5.23 \times 10^{-15} \; W.m^{-2}.Hz^{-1}$$

$$= 5.23 \times 10^{-15} \times 10^7 \; erg.s^{-1}.m^{-2}.Hz^{-1}$$

$$= 5.23 \times 10^{-8} \times 10^{-4} \; erg.s^{-1}.cm^{-2}.Hz^{-1}$$

$$= 5.23 \times 10^{-12} \; erg.s^{-1}.cm^{-2}.Hz^{-1}$$

$\therefore$ photon number,

$$n = \frac{5.23 \times 10^{-12}}{6.6 \times 10^{-27} \times 50 \times 10^9} \; s^{-1}.cm^{-2}$$

$$= 15.85 \times 10^3 \; s^{-1}.cm^{-2}.$$

so, on 200 inch diameter,

$$n = 15.85 \times 10^3 \times 4\pi \, (2.54 \times 200)^2 \; \text{photon/s}$$

$$= 5.137 \times 10^{10} \; \text{photon/s}.$$

6b)
$$\Delta m = -2.5 \times \log_{10}\left(\frac{b_1}{b_2}\right)$$

$$\Rightarrow m_{foreground} - 20.4 = -2.5 \times \log_{10}\left(\frac{L/1}{L/(2\times2)}\right)$$

$$\Rightarrow m_{foreground} = 20.4 - 2.5 \log_{10} 4$$

$$= 18.89$$