Ankitmeena

AA472N/672N : MSE

Ankit Meena (2003121002)

I am Ankit Meena Roll No- 2003121002 hereby declare that during the course of this exam have NOT USED any means of Communication through phone, chat or any messaging, VOIP of Social media app to discuss regarding this exam with any human or any bot.

Ankitmeena

25-01-2021

Ankit Meena

2003121002

(2)

Problem : 1 :→

(a)

given in questions →

$T_{effective} = 3500K$

diameter = 0.045'' , parallax $p = 0.007''$

trigonometric parallax is observed to be $(p) = 0.007''$

There is a simple relationship between a star's distance and and it's parallax angle →

$$d = \frac{1}{p}$$

where → d = distance measured in parsec

p = parallax angle is measured in arc seconds

$$d = \frac{1}{0.007} \text{ pc}$$

$\boxed{d = 142.857 \text{ pc}}$ where 1 parsec = 3.086×10^{16} meters

star radius (in R☉) →

$$\frac{d \times \frac{\theta}{2}}{R_\odot} = \frac{142.857 \times 3.086 \times 10^{16} \times 0.0225}{696.34 \times 10^6}$$

$\boxed{R_\odot = 1.424 \times 10^{20}.}$

Ankit Meena

2003121002

I am using this formula of luminosity -

$$L = 4\pi R_{\odot}^{2} \sigma T^{4}$$

where

R = stellar radius

T = effective temperature

σ = Steffan Boltzmann constant

$$L = 4 \times 3.14 \times 10.424 \times 10^{20} \times 0.000056704 \times \frac{erg}{cm^2 \times K^4} \times (3500^4 \times K^4)$$

$$\boxed{L = 1.32 \times 10^{31}}$$

Astronomy

Ankit Meena

2003121002

4

1 (b)

Sensitivity -

(a) The o. measure of the minimum signal a telescope can distinguish above random background noise

resolution →

So The resolution of a telescope is the Smallest angle between close objects that can be seen clearly to be separate

$\boxed{\text{apparent magnitude of star} = 8.0}$

So it will not be visible to the unaided eye with limiting magnitude 6.0 since is a magnitude 6 digit is more luminous than a magnitude 8 object

So "for every object to be visible to an instrument then apparent magnitude must be lesser than the limiting magnitude of the instruments".

Ankitincome

Ankitincome

20031 21002

1. (c)

~~we know that~~ -

let the apparent magnitude of one star be m_q and the apparent magnitude of 4 stars be m_p then we know that

solution -

$$m_q - m_p = -2.5 \log_{10} \left(\frac{F_q}{F_p}\right)$$

in our question - $f_q = 4 f_p$, $m_p = 8.0$

then -

$$m_q - 8.0 = -2.5 \log_{10} \left(\frac{4 F_p}{F_p}\right)$$

$$m_q = 8.0 - 2.5 \log_{10} 4$$

$$\boxed{m_q = 7.84}$$

//

So the absolute magnitude →

$$7.84 - M = 5 \log \left(\frac{d}{10\,pc}\right)$$

$$M = 7.84 - 5 \log \left(\frac{142.857\,pc}{10\,pc}\right)$$

$$\boxed{M = 2.07}$$

//

Astronomy

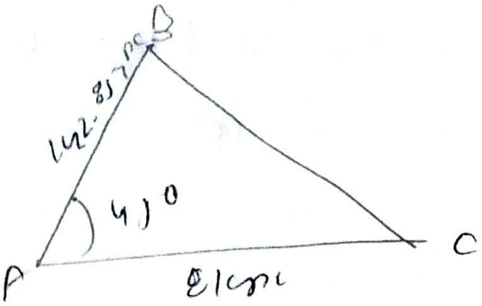
Ankit Meena

2003121002

6

So the apparent magnitude of the system < apparent magnitude of single star.
then system is brighter than individual star.

(d)



given $\theta = 45°$,
we have for the triangle. ABC in fig

$AB = 142.857$ pc

$AC = 8$ kpc

$\angle BAC = 45°$

then cosine rule +

$BC^2 = AB^2 + AC^2 - 2\,AB\,AC\cos 45°$

$BC = (142.857)^2 + (8\text{kpc})^2 - 2 \times 142.857 \times 8\text{kpc} \times \cos 45°$

$\boxed{BC = 7.9 \text{ kpc}}$ Distance from galactic centre

Ankitmeena

Ankit Meena

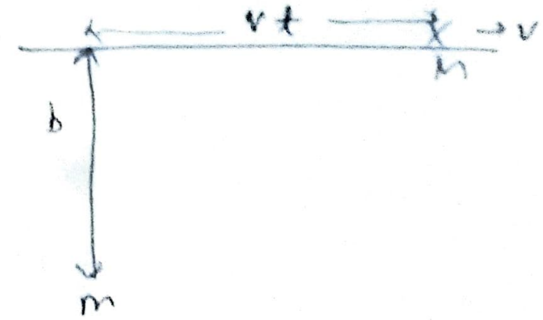
2003121002

7

Problems 4 (a) →

let 'm' be the mass of satellite galaxy moving with a velocity 'v' and 'm' be the mass of star in the galaxy which is at a distance 'b' perpendicular from galaxy M

$$F_\perp = \frac{GmMb}{(b^2+v^2t^2)^{3/2}}$$



$$F_\perp = m\frac{dv_\perp}{dt}$$

$$\Delta v_\perp = \frac{1}{m}\int_{-\infty}^{\infty} F_\perp \, dt$$

$$\boxed{\Delta v_\perp = \frac{2GM}{bv}}$$

$\therefore$ M → b, b + Δb

$$\langle \Delta v_\perp^2 \rangle = \int_{b_{min}}^{b_{max}} n v t \; 2\pi b \, db \, (\Delta v_\perp)^2$$

@Ankitmeena

Ankit Meena

2003121002

8

$$\langle \Delta V_\perp^2 \rangle = \int_{b_{min}}^{b_{max}} n v t \, 2\pi b \, db \times \left(\frac{2 G m}{b v}\right)^2$$

$$\langle \Delta V_\perp^2 \rangle = \frac{8\pi G^2 m^2 n t}{V} \cdot \ln\left(\frac{b_{max}}{b_{min}}\right)$$

$$\boxed{\langle \Delta V_\perp^2 \rangle = \frac{8\pi G^2 m^2 n t \ln\Lambda}{V \ln\Lambda}}$$ — A

where $\Lambda = \frac{b_{max}}{b_{min}}$

if $\langle \Delta V_\perp^2 \rangle \sim V^2$

$$\boxed{t_{relax} = \frac{V^3}{8\pi G^2 m^2 n \ln\Lambda}}$$ — B

For strong encounter the time scale →

$$\boxed{t_s = \frac{V^3}{4\pi G^2 m^2 n}}$$ — C

from equation (B) →

$$\boxed{t_{relax} = \frac{t_s}{2\ln\Lambda}}$$

Astronomy

Ankit Meena

2003121002

For globular cluster -

$$\Rightarrow t_{cross} = \sqrt{\frac{3}{4\pi G\rho}}$$

where $m = 1\, M_\odot$ Assumed

$$\rho = mn \Rightarrow \frac{2\times10^{30}\times10^{4}}{(3.08\times10^{16})^3}\, m^{-3}$$

$$= 7.04\times10^{-16}\ kg\, m^{-3}$$

$$t_{cross} = \sqrt{\frac{3}{4\pi G\rho}}$$

$$t_{cross} = \sqrt{\frac{3}{4\times3.14\times6.67\times10^{-30}\times7.04\times10^{-16}}}$$

$$\boxed{t_{cross} = 7.06\times10^{4}\ yrs}$$

$$\Rightarrow t_{relax} = \frac{v^3}{160\times G^2 m^2 n}$$

$$t_{relax} = \frac{10^{12}\times(3.08\times10^{16})^3}{160\pi\times(6.67\times10^{-11})^2\times1\times10^{10}\times10^{4}}$$

Answers

Ankit Meena

200312100 2

10

$$t_{relax} = \frac{2.42 \times 10^{61}}{8.445 \times 10^{46}} s$$

$$t_{relax} = 3.26 \times 10^{14} s$$

$$\boxed{t_{relax} = 1.03 \times 10^{7} yrs}$$

$\Rightarrow$ $t_s = 40\, t_{relax}$

$t_s = 40 \times 3.26 \times 10^{14}$

$t_s = 1.304 \times 10^{16} s$

$$\boxed{t_s = 4.13 \times 10^{8} yrs}$$

$\Rightarrow$

Ankit meena

Ankit Meena
2003121002

4(b)

For So galaxy →

(i) $t_{coll} = \sqrt{\dfrac{3}{4\pi G \rho}}$

$\rho = mn = 2 \times 10^{30}\,kg \times \dfrac{0.1}{(3.08 \times 10^{16})^3}\,m^{-3}$

$$\boxed{\rho = 6.84 \times 10^{-21}\ kg\,m^{-3}}$$

$t_{coll} = \sqrt{\dfrac{3}{4\pi \times 6.67 \times 10^{-11} \times 6.84 \times 10^{-21}}}$

$t_{coll} = 7.23 \times 10^{14}\,s$

$$\boxed{t_{coll} = 2.3 \times 10^{7}\,yr}$$

(ii) $t_{relax} = \dfrac{v^3}{160\pi G^2 m^2 n}$

$= \dfrac{(30 \times 10^3)^3 \times (3.08 \times 10^{16})^3}{160\pi \times (6.67 \times 10^{-11})^2 \times 4 \times 10^{60} \times 0.1}$

$= \dfrac{7.9 \times 10^{62}}{8.95 \times 10^{41}}\,s = 8.83 \times 10^{20}\,s$

$= 2.8 \times 10^{13}\,yr$

Ankit Meena

2003121002

12

(iii)

$t_s = 40\ t_{relax}$

$t_s = 40 \times 2.8 \times 10^{13}$

$$\boxed{t_s = 1.12 \times 10^{15}\ yrs}$$