Week 2 Problem Session

Wednesday, January 13, 2021 6:06 PM

Size measurement of galaxy:

radius at $\mu(B) = 25 \ \mathrm{mag}/\mathrm{arcsec}^2$

surface brightness in B band.

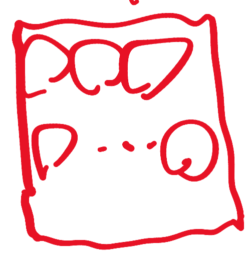
→ independent to distance.

Q: A galaxy at $d = 10\ \mathrm{Mpc}$ → $1\ \mathrm{Mpc}$

How many "Suns" in a pc^2

equiv. to $\mu(B) = 25 \ \mathrm{mag}/\mathrm{arcsec}^2$

pc^2



25 mag in B band

Given. (Table 1.4)

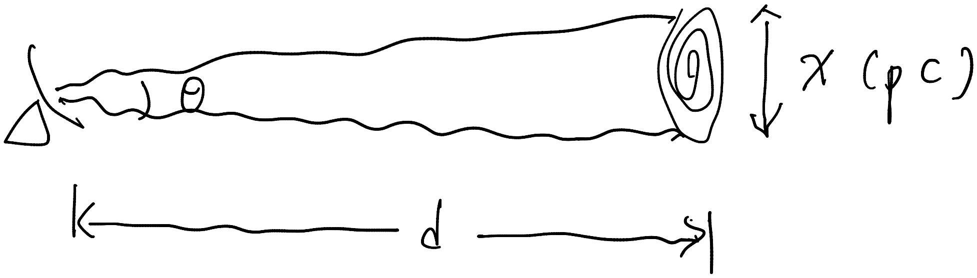
Sun: $M_V = 4.83$, $B-V = 0.65$

① Convert arcsec to pc

② Convert $M_V \rightarrow M_B$

③ Compare $M_\odot$ of 1 sun & N-suns.

① arcsec → parsec



$x\,(pc) = d \cdot \underset{rad}{\theta}$

$\theta = 1'' = \left(\frac{1}{3600}\right)^{\circ} = \frac{1}{3600} \times \frac{\pi}{180} = \boxed{\frac{1}{206265}}$

$d = 10\ Mpc = 10^7\ pc$

$\Rightarrow x = d\theta = \underset{10^6}{10^7} \times \frac{1}{206265} = \overset{4.85}{48.5\ (pc)}$

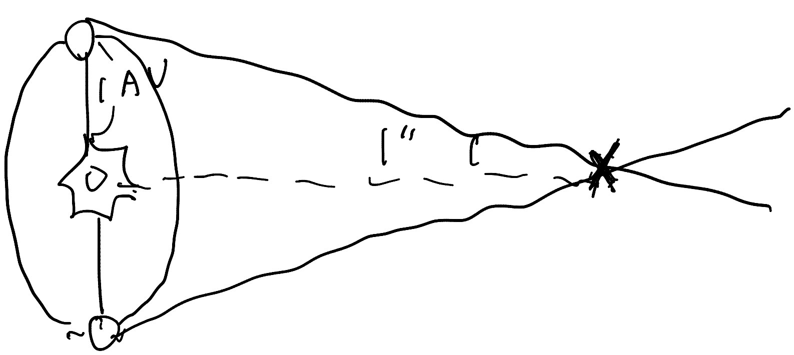
$\qquad\qquad\qquad\qquad\qquad\qquad \shortparallel$

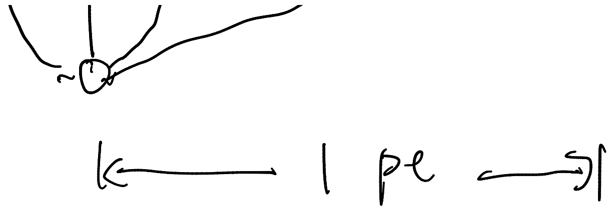
$\qquad\qquad\qquad\qquad\qquad\quad$ 1 arcsec

$1\ pc = 206265\ AU$

$\Rightarrow 48.5\ pc = 10^7\ AU$

same as
↘ distance in pc!





$\Rightarrow 1\,\text{AU} = 1\,\text{pc} \cdot \underbrace{1''}_{\text{rad}}$

If observing object at "d" pc

$\Rightarrow 1'' \longleftrightarrow d$ AU

$\therefore 1''$ for 10 Mpc $\longleftrightarrow$ 48.5 pc

$\Rightarrow 1\ \text{arcsec}^2 \longleftrightarrow (48.5)^2\ \text{pc}^2$

$= 2352\ \text{pc}^2$

$\rightarrow 23.52$

② $M_V \rightarrow M_B$

$\left[\begin{array}{l} M_V = 4.8 \\ B-V = 0.65 \end{array}\right\}$ Sun.

$M_B = M_V + (B-V) = 5.48$ mag

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Distance modulus:

$$m - M = 5\log(d) - 5$$

$$5.48 = 5\log(10^7) - 5 = 30$$

10^6 25

$$\Rightarrow m_{\odot(B)} = 30 + 5.48 = 35.48$$

30.48.

③ Compare m of N "Suns" & 1 Sun.

$$m_1 - m_2 = -2.5\log\left(\frac{F_1}{F_2}\right)$$

$$\Rightarrow \underbrace{m_{tot}}_{25} - \underbrace{m_\odot}_{35.48} = -2.5\log\underbrace{\left(\frac{\boxed{F_{tot}}}{F_\odot}\right)}_{N}$$

$= N \cdot F_\odot$

$$= -2.5\log(N) = -10.48$$

$$\Rightarrow N = 10^{\frac{10.48}{2.5}} = \boxed{15560} \rightarrow 155.6$$

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To produce $\mu(B) = 25 \ \mathrm{mag}/\mathrm{arcsec}^2$

$\equiv$ 15560 Suns (in B band)

in $\boxed{2352}\ \mathrm{pc}^2 \rightarrow 23.52$

($1\ \mathrm{arcsec}^2$)

$$= \frac{15560}{2352} = \underline{6.6} \ \mathrm{Suns}/\mathrm{pc}^2 \qquad \propto d^2$$

$$\rightarrow \frac{155.6}{23.52} = 6.6 \ \mathrm{Suns}/\mathrm{pc}^2$$

$\rightarrow$ surface brightness is invariant with distance!