

3) STG 1.8 EFFECTIVE TEMP IS DEFINED BY:

$$L = 4\pi R^2 \sigma T_{\text{eff}}^4$$

$$T_{\text{eff}} = \left(\frac{L}{4\pi R^2 \sigma} \right)^{1/4}$$

$$= \left(\frac{(2 \times 10^{10} L_{\odot}) \left(\frac{3.85 \times 10^{26} \text{ W}}{L_{\odot}} \right)}{4\pi (8 \times 10^3 \text{ pc})^2 \left(\frac{5.67 \times 10^{-8} \text{ W}}{\text{m}^2 \text{K}^4} \right)} \right)^{1/4}$$

$$= \boxed{3.6 \text{ K}}$$

WELL, THAT'S SORTA 5K...

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QUICK WAY

STAR HAS MAG m
YOU MEASURE $m \pm 0.1$

REAL DIST:

$$M - m = 5 \log \frac{d}{10 \text{ pc}}$$

$$d = (10 \text{ pc}) (10^{(M-m)/5})$$

CALCULATED DIST:

$$m \pm 0.1 - M = 5 \log \frac{d'}{10 \text{ pc}}$$

$$d' = (10 \text{ pc}) (10^{(m \pm 0.1 - M)/5})$$

$$d' = (10 \text{ pc}) (10^{(m-M)/5}) (10^{\pm 0.1/5})$$

DIFFERENCE: (HOW WRONG YOU ARE)

$$d' - d = (10 \text{ pc}) (10^{(m-M)/5}) (10^{\pm 0.1/5} - 1)$$

FRACTIONAL ERROR:

$$\left| \frac{d' - d}{d} \right| = \left| 10^{\pm 0.1/5} - 1 \right|$$

$$= \boxed{0.05}$$

5% ERROR IN d

DERIVATIVE WAY

UNCERTAINTY IN m
IS $\Delta m = 0.1$

$$M - m = 5 \log \frac{d}{10 \text{ pc}}$$

$$d = 10 \text{ pc} 10^{(M-m)/5}$$

$$\frac{\partial d}{\partial m} = (10 \text{ pc}) (10^{(M-m)/5}) \ln 10 \left(-\frac{1}{5} \right)$$

$$\Delta d = \left| \frac{\partial d}{\partial m} \right| \Delta m$$

$$\frac{\Delta d}{d} = \frac{10 \text{ pc} 10^{(M-m)/5} (\ln 10) \left(\frac{1}{5} \right)}{10 \text{ pc} 10^{(M-m)/5}} 0.1$$

$$\frac{\Delta d}{d} = \left(\frac{\ln 10}{5} \right) 0.1 = \left(\frac{2.3}{5} \right) (0.1)$$

$$\left| \frac{\Delta d}{d} \right| = \boxed{0.05}$$

5% ERROR IN d

5) DISTANCE MODULUS FOR MAG 20 STAR

a) $= 20 - 4.8 = 15.2 = 5 \log\left(\frac{d}{10\text{pc}}\right)$

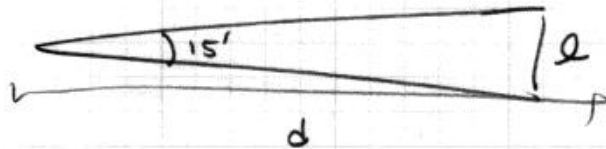
$$\left(10^{\frac{15.2}{5}}\right) 10\text{pc} = d$$

IN GENERAL,

$$d = \left(10^{\frac{m-4.8}{5}}\right) (10\text{pc})$$

$$d = 11,000\text{pc} = 11\text{kpc}$$

b) AT DISTANCE d , $15'$ FOV CORRESPONDS TO PHYSICAL LENGTH:



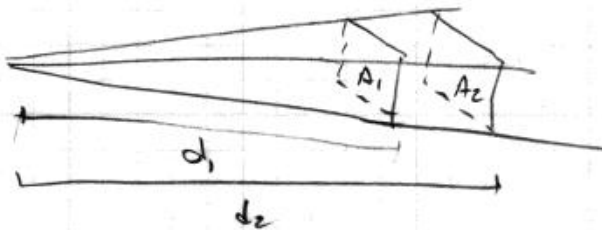
$$\frac{l/2}{d} = \tan \frac{15'}{2}$$

$\tan \alpha \approx \alpha$ FOR α IN RADIANS

$$(15') \left(\frac{60''}{1'}\right) \left(\frac{1\text{rad}}{206265''}\right) = 4.36 \times 10^{-3} \text{rad}$$

THUS $l = (4.36 \times 10^{-3}) d$

VOLUME SAMPLED FROM d_1 TO d_2



$$= \frac{A_2 d_2}{3} - \frac{A_1 d_1}{3} = \frac{l_2^2 d_2}{3} - \frac{l_1^2 d_1}{3}$$

$$= \frac{1}{3} (4.36 \times 10^{-3})^2 (d_2^3 - d_1^3)$$



VOLUME OF A
PYRAMID = $\frac{Ah}{3}$

5 cont'd

For $m_1 = 19$ & $m_2 = 20$

$$\text{VOL} = \frac{1}{3} (4.36 \times 10^{-3})^2 \left(10^{\frac{3}{5}(20-4.8)} - 10^{\frac{3}{5}(19-4.8)} \right) (10 \text{ pc})^3$$

$$= 6.26 \times 10^6 \text{ pc}^3$$

~~144~~

$$\# \text{ STARS} = \left(\frac{1 \text{ STAR}}{25 \text{ pc}^3} \right) (6.26 \times 10^6 \text{ pc}^3)$$

$$= 250,000 \text{ STARS}$$

$$\text{BET MAG 19 \& 20}$$

$$\text{THAT'S A LOT!}$$

WE'RE TALKIN' ONE CROWDED IMAGE HERE

(c) SAME CALCULATION, ONLY $m_1 = 12$ & $m_2 = 13$

$$\text{VOL} = \frac{1}{3} (4.36 \times 10^{-3})^2 \left(10^{\frac{3}{5}(13-4.8)} - 10^{\frac{3}{5}(12-4.8)} \right) (10 \text{ pc})^3$$

$$= 395 \text{ pc}^3$$

$$\# \text{ STARS} = \left(\frac{1 \text{ STAR}}{25 \text{ pc}^3} \right) (395 \text{ pc}^3)$$

$$= 16 \text{ STARS BET MAG 12 \& 13}$$

(d) NOW WE GOTTA TURN IT AROUND

FOR 1 STAR, WE NEED TO SAMPLE
 25 pc^3

$$25 \text{ pc}^3 = \frac{(4.36 \times 10^{-3})^2}{3} \left(10^{\frac{3}{5}(m+0.5-4.8)} - 10^{\frac{3}{5}(m+0.5-4.8)} \right) (10 \text{ pc})^3$$

$$3945 = 10^{\frac{3}{5}(m-4.3)} - 10^{\frac{3}{5}(m-5.3)}$$

$$= 10^{\frac{3}{5}m} \left(10^{-4.9\frac{3}{5}} - 10^{-5.3\frac{3}{5}} \right)$$

$$= 10^{\frac{3}{5}m} (1.97 \times 10^{-5})$$

$$10^{\frac{3}{5}m} = 2.00 \times 10^6$$

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5 cont'd

$$\frac{3}{5} m = 6.3$$

$$m = 10$$

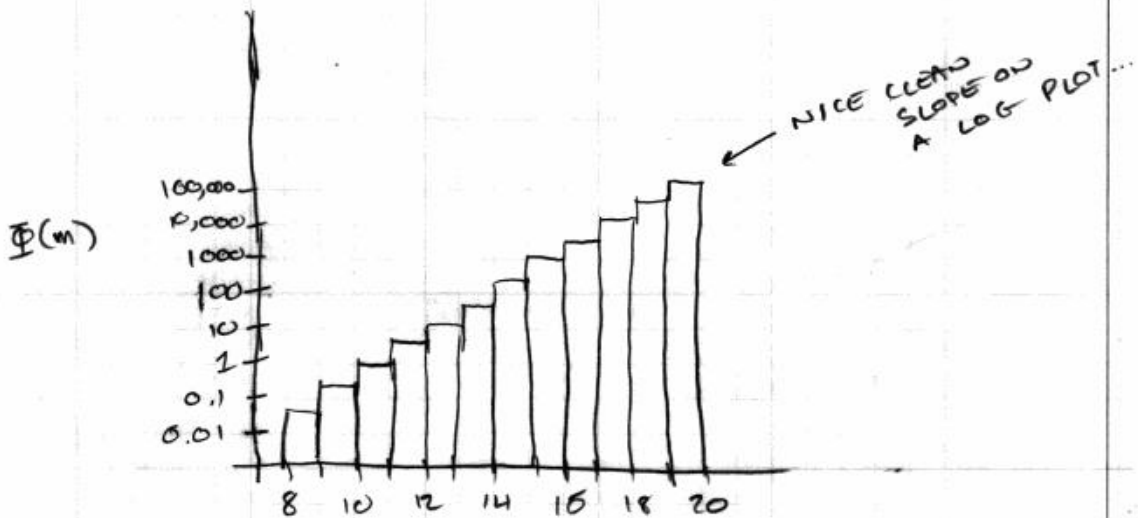
N MAG 10 IS THE BRIGHTEST STAR YOU EXPECT TO SEE IN THIS FRAME.

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GRAB IT OUT

m	mz	NUMBER
8	9	0.063
9	10	0.25
10	11	1.0
11	12	4.0
12	13	16
13	14	63
14	15	250
15	16	1,000
16	17	4,000
17	18	16,000
18	19	63,000
19	20	250,000

NOTE EACH STEP HAS 4X PREVIOUS STEP



f DUST!

