1

(a)

(b)

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

$$19 - M = 5 \log\left(\frac{1000pc}{10pc}\right) = 5 \log(100) = 10$$

$$\boxed{M = 9}$$

(c) THIS IS ABOUT AN M0 MAIN-SEQ. STAR ⇒ A RED DWARF $B-V \sim 0.8$

(ALMOST) ANY 1 STAR BLUER THAN THIS WILL BE BRIGHTER, THUS @ LOWER ABS. MAGNITUDE.

SOME WHITE DWARFS ARE BLUER DIMMER

ANYWHERE IN THE DISK BLUER STARS WILL BE AT THIS DISTANCE OR CLOSER, SO THEY WILL BE AT $M < 19$ AND THUS NOT IN THE PLOT

(d) HORIZONTAL BRANCH STARS HAVE $\boxed{B-V \sim 0.25}$ & $M_B \sim 0.5$ ish

← OOPS, I GAVE YOU THE WRONG PLOT

B-V = 0.15
B-0.5=0.25

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

$$d = 10pc \; 10^{(m-M)/5} = 10pc \; 10^{(19-0.5)/5}$$

$$= 10pc \left(10^{3.7}\right) = \underline{50kpc}$$

WAY OUT IN THE HALO

(e) FOR STARS IN THE DISK, THE DISK IS THIN ENOUGH THAT ANYTHING BLUER THAN $B-V \sim 1$ WILL BE SO CLOSE THAT IT HAS $M < 19$ (BRIGHTER THAN 19TH MAG.). THUS, THIS PLOT SHOWS RED DWARFS IN THE THIN DISK. THE HALO IS BIG, THOUGH, SO WE CAN SEE RELATIVELY BLUER LOW-METALLICITY M.B. STARS @ $m = 19$.

R (6)

$\frac{1}{16}$ FLUX FROM ONE CORNER 1" × 1"

$$\frac{F_{corner}}{F_{tot}} = \frac{1}{4}$$

$$m_{corner} - m_{tot} = -2.5 \log \frac{F_{corner}}{F_{tot}}$$

$$= -2.5 \log \left(\frac{1}{16}\right)$$

$$m_{corner} - m_{tot} = 3.0$$

$$m_{corner} = m_{tot} + 3.0 = 13$$

SURFACE BRIGHTNESS = 13 mag/□"

⇒ IT SHOULD BE OBVIOUS THAT $\frac{10}{16}$ IS THE WRONG NUMBER! (MAGNITUDES ARE LOGS)

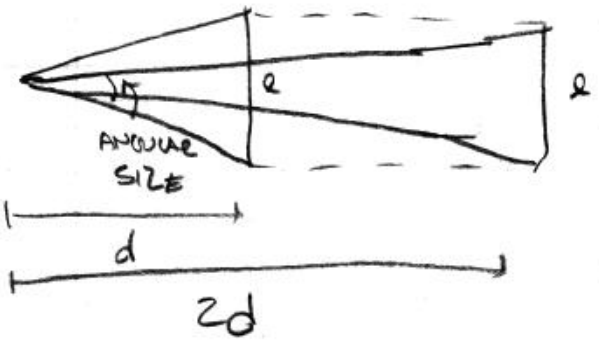
(b)

$$\frac{F_{far}}{F_{near}} = \left(\frac{d_{near}}{d_{far}}\right)^2 = \left(\frac{1}{2}\right)^2 = \frac{1}{4}$$

$$m_{far} - m_{near} = -2.5 \log \frac{F_{far}}{F_{near}} = -2.5 \log \frac{1}{4} = 1.5$$

$m_{far} = 11.5$ DIMMER ⇒ HIGHER MAGNITUDE

(c)



$\frac{\ell}{d} \sim \alpha$

IF $d \to 2d$

$\alpha \to \frac{1}{2}\alpha$

2" × 2"

⇒

2(d) REPEAT (a)

corner 1" × 1"

$M_{corner} - m_{tot} = -2.5 \log\left(\frac{F_{corner}}{F_{tot}}\right) = -2.5 \log\left(\frac{1}{4}\right)$

$= +1.5$

$M_{corner} = M_{tot} + 1.5 = 11.5 + 1.5 = 13$

13 mag/□" SAME AS (a)!

3(a) FLUX @ SURFACE OF BLACKBODY $= \sigma T^4$

$F_{@surf} = \left(5.67 \times 10^{-8} \frac{W}{m^2 K^4}\right)(5800K)^4$

$= \boxed{6.4 \times 10^7 \frac{W}{m^2}}$

(b) ANGULAR SIZE OF SUN $= \pi\left(\frac{1}{4}^\circ\right)^2$

$= \pi(15')^2$

$= \pi\left(15'\left(\frac{60''}{1'}\right)\right)^2 = 2.5 \times 10^6 \, \square''$

$FLUX = \frac{L}{4\pi d^2} = \frac{3.86 \times 10^{26} W}{4\pi (1.5 \times 10^{11} m)^2}$

$= 1400 \frac{W}{m^2}$

SURF. BRIGHT $= \frac{1400 \frac{W}{m^2}}{2.5 \times 10^6 \, \square''} = \boxed{5 \times 10^{-4} \frac{W/m^2}{\square''}}$

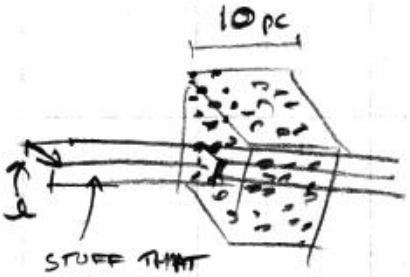
VERY DIFFERENT FROM (a)!

(c) $\frac{F_{1\square''}}{F_{tot}} = \frac{1 \square''}{2.5 \times 10^6 \, \square''}$

$m - m_{tot} = -2.5 \log\left(\frac{1}{2.5 \times 10^6}\right) = 16$

$m = -26.7 + 16 = \boxed{-10.7}$ STILL A LOT BRIGHTER (FOR TYPICAL STARS)

(4) OOPS → YOU DO NEED THE THICKNESS OF THE CLUSTER! ASSUME 10pc FOR SOMETHING TO DO



YOU LOOKING

CHOOSE ℓ SO THAT IT CORRESPONDS TO 1"

WHAT IS ℓ?

$$\frac{\ell}{d} = (1'')\left(\frac{1\ rad}{206265''}\right)$$

WHAT IS d?

NOTE THAT SURFACE BRIGHTNESS DOESN'T DEPEND ON d, SO WE CAN PRETEND WHATEVER d WE WANT AND GET THE RIGHT ANSWER!

FOR SIMPLICITY, ASSUME $d = 10pc$

THEN $m = M$

m ↑ APPARENT MAG; M ↑ ABSOLUTE MAG

YOU CAN CHOOSE WHATEVER YOU WANT, BUT THIS MAKES THE APPARENT/ABSOLUTE CONVERSION TRIVIAL

THEN $\ell = (10pc)\left(\frac{1}{206265}\right) = 5 \times 10^{-5} pc$

TOTAL VOLUME SAMPLED = $(\ell^2)(10pc)$

$= 2.4 \times 10^{-8} pc^3$

$\#\ STARS = (2.4 \times 10^{-8} pc^3)\left(10\ \frac{stars}{pc^3}\right) = 2.4 \times 10^{-7}$ stars

(IF THAT CONCEPTUALLY BOTHERS YOU, DO $d = 10^6 pc$ AND CONVERT $m \rightarrow M$ LATER)

4 cont'd

RED CLUMP STAR → $M_V \sim 0.5$ (FIG 2.2)

THUS $m = 2.5$

$$\frac{F_{1\square''}}{F_{1\,star}} = 2.4 \times 10^{-7}$$

↑ # STARS IN 1 □''

$$m_{1\square''} - m_{1\,star} = -2.5 \log \frac{F_{1\square''}}{F_{1\,star}} = -2.5 \log(2.4 \times 10^{-7}) = 19$$

$$m_{1\square''} \simeq 19.5 \ \frac{\text{mag}}{\square''}$$

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