Astrophysics Ch 3 # 1, 6, 8, 13

Universe Ch 5 # 6, 11, 25, 27, 29, 34, 36 due Mon 9 Feb 04

Universe Ch 19 # 25, 34, 35, 43, 46, 50, 52

Universe Ch 5 - The Nature of Light

#6 Cell phone transmits + receives radio waves.

If $f = 893.07$ MHz, find wavelength λ.

speed = frequency · wavelength

$c = f\lambda$

#11 Aldebaran has $T = 3850$ K.

(a) Find wavelength of maximum emission and (b) color.

(a) $\lambda_{max}(m) = \frac{0.0029}{T(K)} \simeq \frac{3\cdot 10^{-3}}{3850} = \_\_\_\_\_\_$ m

(b) From Fig 5-10 (99), this looks like a ______ black body

4.5

*25. The bright star Sirius in the constellation of Canis Major (the Large Dog) has a radius of 1.67 $R_\odot$ and a luminosity of 25 $L_\odot$. (a) What is the energy flux at the surface of Sirius? (b) What is the star's surface temperature?

See p. 102-103

(a) $F = \frac{L}{4\pi R^2} =$

(b) $F = \sigma T^4$ where $\sigma = 5.67 \times 10^{-8} \frac{W}{m^2 K^4}$ = Stefan-Boltzmann const

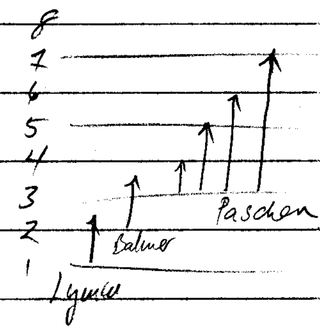
27. In Figure 5-12 you can see two distinct dark lines at the boundary between the orange and yellow parts of the Sun's spectrum (in the center of the third colored band from the top of the figure). The wavelengths of these dark lines are 588.99 and 589.59 nm. What do you conclude from this about the chemical composition of the Sun's atmosphere?

These are sodium lines, dark because the Sun's atmosphere absorbs them. Therefore Sun's atmosphere contains Sodium.

29. (a) Calculate the wavelength of P_δ, the fourth wavelength in the Paschen series. (b) Draw a schematic diagram of the hydrogen atom and indicate the electron transition that gives rise to this spectral line. (c) In what part of the electromagnetic spectrum does this wavelength lie?

n=3-7

Fig 5-22



$\frac{1}{\lambda^2} = R\left(\frac{1}{N^2_{in}} - \frac{1}{n^2_{out}}\right)$

$= 1.097 \times 10^7 \frac{1}{m}\left(\frac{1}{3^2} - \frac{1}{7^2}\right) =$

$\lambda =$ ______ m

(IR)

34. The wavelength of H_β in the spectrum of the star Megrez in the Big Dipper (part of the constellation Ursa Major, the Great Bear) is 486.112 nm. Laboratory measurements demonstrate that the normal wavelength of this spectral line is 486.133 nm. Is the star coming toward us or moving away from us? At what speed?

$= \lambda'$

$= \lambda$

$\lambda - \lambda' = 486.133$ nm

$- 486.112$ nm

$\Delta\lambda =$ ____ nm

redshifted or blueshifted?

larger or shorter λ?

$\frac{v}{c} = \frac{\Delta\lambda}{\lambda} =$ ____

$v = (\quad\quad) 3\times10^8 \frac{m}{s} =$ ____ $\frac{m}{s}$

36. You are given a traffic ticket for going through a red light (wavelength 700 nm). You tell the police officer that because you were approaching the light, the Doppler effect caused a blueshift that made the light appear green (wavelength 500 nm). How fast would you have had to be going for this to be true? Would the speeding ticket be justified? Explain.

$\lambda - \lambda' = 700 - 300$ nm

$\Delta\lambda =$ ____ nm

$\frac{v}{c} = \frac{\Delta\lambda}{\lambda} =$

$v = (\quad\quad) 3\times10^8 \frac{m}{s} =$

$=$ ____ $\frac{m}{s} \left| \frac{km}{10^3\,m} \right| \frac{3600\,s}{hr} =$ ____ $\frac{km}{hr}$

The Nature of Stars

E7 - due Mon 9 Feb 04

Universe Ch 19 # 25, 34, 35, 43, 46, 50, 52

25 Dim star is $d = 2\times10^6$ AU / $\frac{1.5\times10^8 \text{ km}}{\text{AU}}$ / $\frac{\text{pc}}{3.1\times10^{13} \text{ km}}$ = ______ pc
from Sun.

(b) Find parallax angle $p(\text{arc sec}) = \frac{1}{d(\text{pc})} =$ ______

33. Stars *A* and *B* are both equally bright as seen from Earth, but *A* is 60 pc away while *B* is 15 pc away. Which star has the greater luminosity? How many times greater is it?

Box 19-2 p. 425:

$\frac{L_A}{L_B} = \left(\frac{d_A}{d_B}\right)^2 \frac{b_A}{b_B}$ $d_A = 60$ pc $d_B = 15$ pc

Equally bright: $b_A = b_B$

$\frac{L_A}{L_B} =$

34. Stars C and *D* both have the same luminosity, but C is 36 pc from Earth while *D* is 12 pc from Earth. Which star appears brighter as seen from Earth? How many times brighter is it?

$L_C = L_D$ $d_C = 36$ pc $d_D = 12$ pc

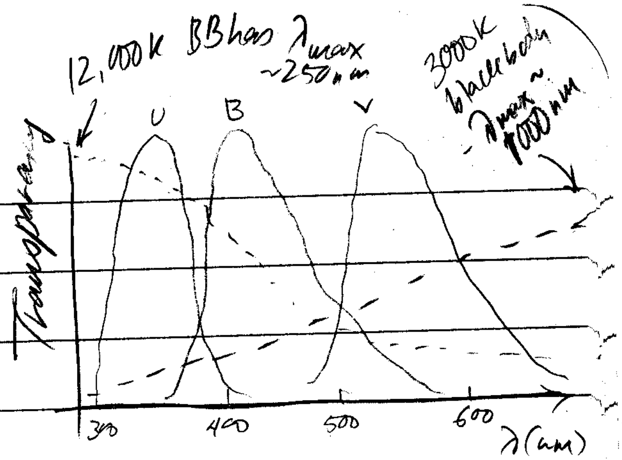
$\frac{b_C}{b_D} =$

35. Suppose two stars have the same apparent brightness, but one star is 12 times farther away than the other. What is the ratio of their luminosities? Which one is more luminous, the closer star or the farther star?

$b_1 = b_2$ $d_1 = 12\, b_2$

$\frac{L_1}{L_2} =$

(43) (a) On a copy of Figure 19-8, sketch the intensity curve for a blackbody at a temperature of 3000 K. Note that this figure shows a smaller wavelength range than Figure 19-7*a*. (b) Repeat part (a) for a blackbody at 12,000 K (see Figure 19-7*c*). (c) Use your sketches from parts (a) and (b) to explain why the color ratios b_V/b_B and b_B/b_U are less than 1 for very hot stars but greater than 1 for very cool stars.



G.5: $\lambda_{max}(m) = \frac{3\times10^{-3}}{T(K)}$

$\lambda_a = \frac{3\times10^{-3}}{3000\,K} = 10^{-6}\,m = 10^{3}\,nm$ = peak wavelength for 3000K BB

$\lambda_b = \frac{3\times10^{-3}}{12,000K} = \frac{1}{4}\times10^{-6}\,m = \frac{1000}{4}\,nm = 250\,nm$

$U > B > V$

Hotter Blackbody (BB) has more U (UV) light. $b_u > b_B > b_V$

Cooler BB has more V (visible) light $b_V > b_B > b_u$

$V > B > V$

Hotter Blackbody $\frac{b_u}{b_B} > 1$ and $\frac{b_B}{b_V} > 1$ because λ peaks in UV

So $\frac{b_B}{b_u} < 1$ and $\frac{b_V}{b_B} < 1$ because λ peaks in Vis

Cooler: $\frac{b_V}{b_B} < 1$ and $\frac{b_B}{b_u} < 1$ so $\frac{b_B}{b_V} > 1$ and $\frac{b_u}{b_B} > 1$

(46) The bright star Rigel in the constellation Orion has a surface temperature about 1.6 times that of the Sun. Its luminosity is about 64,000 $L_\odot$. What is Rigel's radius compared to the radius of the Sun?

Box 19-4 p. 436: $L = 4\pi\sigma R^2 T^4$

$\frac{L}{L_\odot} = \frac{4\pi\sigma R^2 T^4}{4\pi\sigma R_\odot^2 T_\odot^4} = \frac{R^2 T^4}{R_\odot^2 T_\odot^4} \rightarrow \frac{R}{R_\odot} =$

(U1) (U2) (U3) (U4) (A3)

(50) The bright star Zubeneschmali (β Librae) is of spectral type B8 and has a luminosity of 130 $L_\odot$. What is the star's approximate surface temperature? How does its radius compare to that of the Sun?

Table 19-2 p. 435

B8 star has T ~

$$\frac{L}{L_\odot} = \left(\frac{R}{R_\odot}\right)^2 \left(\frac{T}{T_\odot}\right)^4 \rightarrow \frac{R}{R_\odot} =$$

(52) A brown dwarf called CoD–33°7795 B has a luminosity of $0.0025 L_\odot$. It has a relatively high surface temperature of 2550 K, which suggests that it is very young and has not yet had time to cool down by emitting radiation. (a) What is this brown dwarf's spectral class? (b) Find the radius of CoD–33°7795 B. Express your answer in terms of the Sun's radius and in kilometers. How does this compare to the radius of Jupiter? Is the name "dwarf" justified?