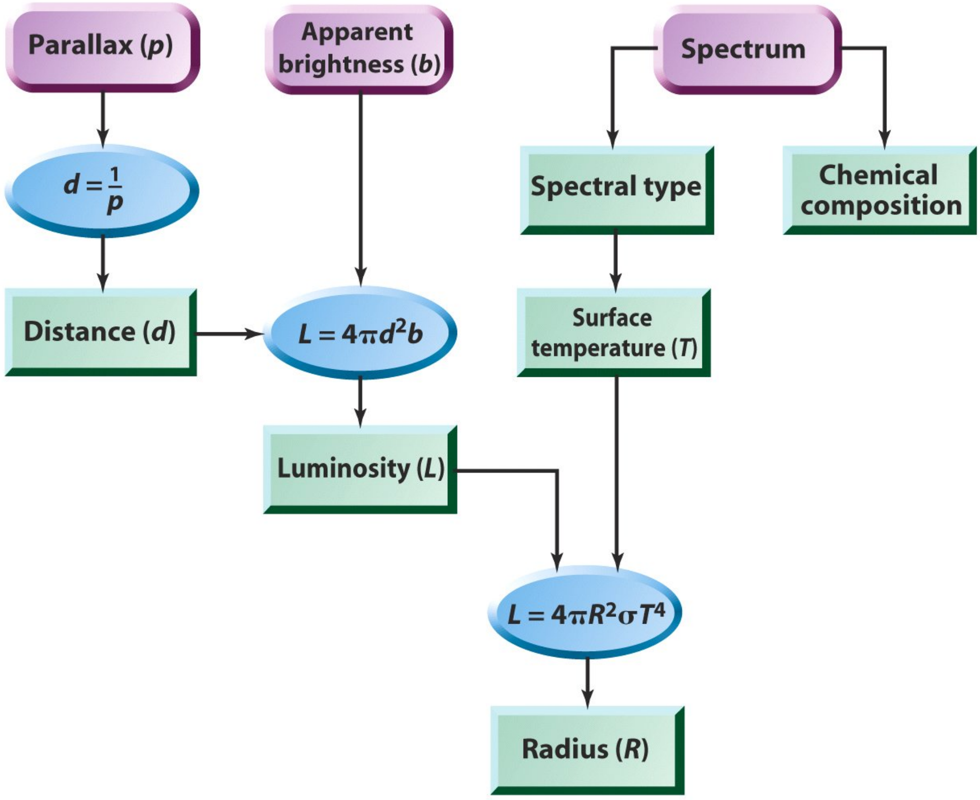
Chapter 11: Characterizing Stars

Chapter 11: Characterizing Stars Pg 339 #1 - 5, 9, 10, 12, 13, 15 - 19, 26 - 29, 31, 32, 35, 36, 40.

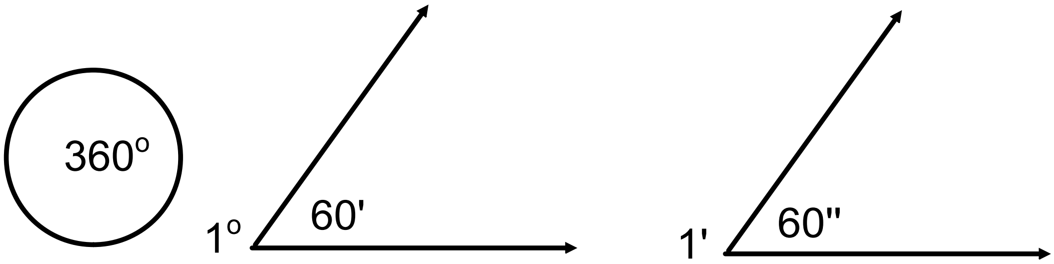


$$L_* = 4\pi R_*^2 \sigma T_*^4 \qquad L_\odot = 4\pi R_\odot^2 \sigma T_\odot^4$$

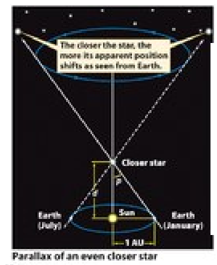
$$\frac{L_*}{L_\odot} = \frac{4\pi R_*^2 \sigma T_*^4}{4\pi R_\odot \sigma T_\odot^4}$$

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

Degrees - Minutes - Seconds



Stellar Distances: Parallax



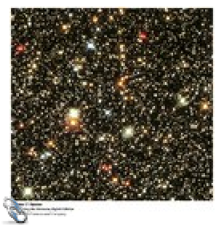
Parallax of an even closer star

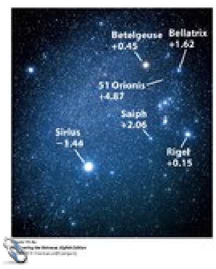
$$d = \frac{1}{p}$$

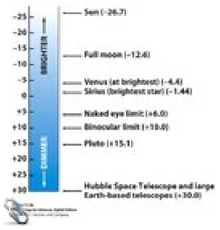
d = distance in parsecs
p = parallax angle in arcseconds

1 pc = 3.26 ly

Counter Intuitive Brightness Scale







m = apparent magnitude
M = absolute magnitude

Star of *m* = 6 is 100x brighter than a star of *m* = 1

Distance-Magnitude Relationship

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

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

Try These Page 323

A star is observed to have an apparent magnitude m = +0.268 and an absolute magnitude M = -0.01. How far is it from Earth in parsecs and light years?

$m = 0.268$

$M = -0.01$

$d = ?$

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

$(0.268) - (-0.01) = 5\log(d) - 5$

$0.278 = 5\log(d) - 5$ (Isolate)

$5.278 = 5\log(d)$

$1.0556 = \log(d)$

$10^{1.0556} = d$

$11.4\,pc = d$

$11.4\,pc \times \frac{3.26\,ly}{1\,pc}$

$= 37\,ly$

A star is observed to have an apparent magnitude m = +1.17 and is at a distance of 25.1 ly from Earth. What is its absolute magnitude?

$m = 1.17$

$M = ?$

$d = 25.1\,ly \times \frac{1\,pc}{3.26\,ly} = 7.7\,pc$

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

$1.17 - M = 5\log(7.7) - 5$

$1.17 - M = 5(0.886) - 5$

$1.17 - M = -0.5675$

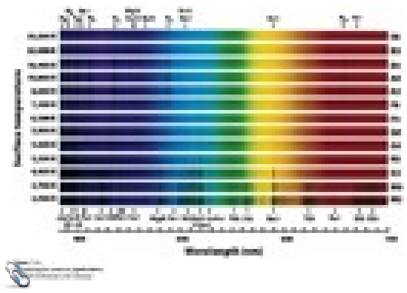
$1.17 + 0.5675 = M$

$1.74 = M$

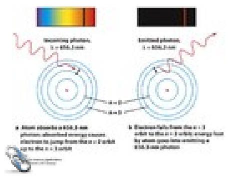
Wolf 359 has a parallax angle of 0.419" and an apparent magnitude of +13.44. What is its absolute magnitude?

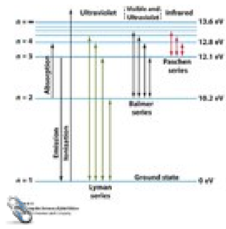
Surface Temperature by Colour and Spectra

Surface colour corresponds to the peak of the blackbody curve.



A star's spectra is a result of the surface temperature and composition. *Stellar Spectroscopy*.



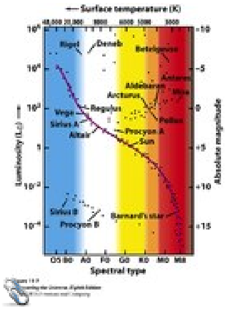


Classifying Stars - Another Unconventional Naming Scheme

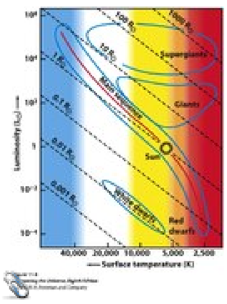
Oh Be A Fine Girl (Guy) Kiss Me [Right Now Smack]

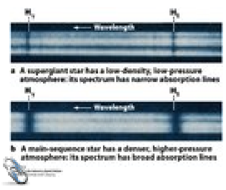
Subdivided into subclasses based on surface temperature.

The Hertzsprung-Russell Diagram

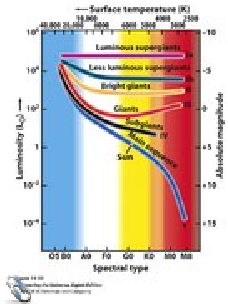


Spectral Classes





Luminosity Classes



Knowing a star's position on the H-R Diagram leads to a value of absolute magnitude - *Spectroscopic Parallax*

- Stellar Masses are difficult to determine.
- Calculated through Kepler's Third Law

Spectral Classification Assignment Examples

Kraz ↙ State of evolution
G5 III
m = 2.62
M = -0.54
T = 5097 K
L = 188 L_{sun}
R = ? R_{sun}
D = ? parsecs

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

$$\frac{(188\, L_\odot)}{L_\odot} = \left(\frac{R}{R_\odot}\right)^2\left(\frac{5097}{5800}\right)^4$$

$$L = R^2\left(\frac{T}{5800}\right)^4 \qquad \sqrt[y]{x} \qquad x^{y} \leftarrow 0.25$$

$$188 = R^2\left(\frac{5097}{5800}\right)^4$$

$$188 = R^2(0.8788)^4$$

$$188 = R^2(0.5964)$$

$$315 = R^2$$

$$\boxed{17.8\,R_\odot = R}$$

Calculate Star's radius in A.U.

$$17.8\,R_\odot \times \frac{6.96\times10^8\,m}{R_\odot} \times \frac{1\,AU}{1.5\times10^{11}\,m}$$

$$\simeq 0.083\ AU$$

Will not engulf any planets.

Spectral Classification Assignment Examples

Alphard
K3 II
$m = 1.96$
$M = ?$
$T = 5097$ K
$L = ?\ L_{sun}$
$R = 113\ R_{sun}$
$p = 0.0184''$

$$L = R^2\left(\frac{T}{5800}\right)^4$$

$$L = (113)^2\left(\frac{5097}{5800}\right)^4$$

$$L = (12769)(0.5964)$$

$$\boxed{L = 7610\ L_\odot}$$

$$R = 0.524\ AU$$

$$m - M = 5\,Log(d) - 5$$

$$M = 5 - 5\,Log(d) + m$$

$$d = \frac{1}{p} = \frac{1}{0.0184} = 54.3\ pc$$

$$M = 5 - 5\,Log(54.3) + (1.96)$$

$$= 5 - 8.674 + 1.96$$

$$\boxed{= -1.71}$$

Spectral Classification Assignment Examples

Arcturus
K3 II
m = -0.07
M = -0.33
T = ? K
L = 298 L_{sun}
R = 34 R_{sun}
p = ? "

$$L = R^2\left(\frac{T}{5800}\right)^4$$

$$298 = 34^2\left(\frac{T}{5800}\right)^4$$

$$\frac{298}{34^2} = \left(\frac{T}{5800}\right)^4$$

$$0.2578 = \left(\frac{T}{5800}\right)^4$$

$$\sqrt[4]{0.2578} = \sqrt[4]{\left(\frac{T}{5800}\right)^4}$$

$$0.7125 = \frac{T}{5800}$$

$$\boxed{4133^\circ K = T}$$

$P = ?$

$d = ?$

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

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

$$(-0.77) - (-1.33) = 5\log(d) - 5$$

$$0.56 = 5\log(d) - 5$$

$$5.56 = 5\text{Log}(d)$$

$$1.112 = \text{Log}(d)$$

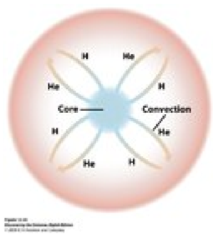
$$10^{1.112} = d$$

$$12.9\text{pc} = d$$

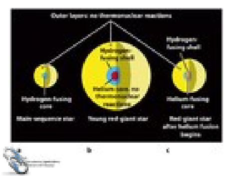
$$P = \frac{1}{12.9} = \boxed{0.077''}$$

Chapter 12.8 to 12.14:
Stellar Evolution of Low Mass Stars

Mstar < 0.4 Msun



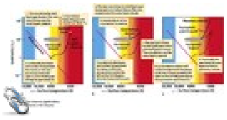
Mstar > 0.4 Msun



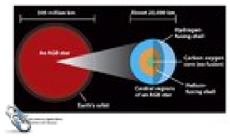
- Helium Fusion in the Core
- Helium Flash for 0.4 to 2 Msun stars
- Electron Pressure
- Helium burning creates more massive elements

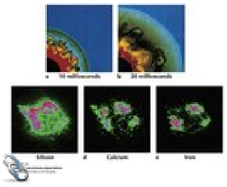
Pg 374 # 2, 6, 7, 10, 11, 14 - 16, 25 - 29.

Chapter 13
The Death of Stars

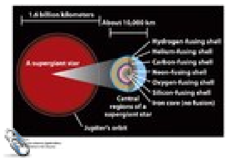


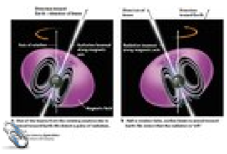
Low mass stars form planetary nebulae



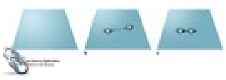


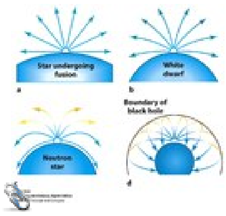
High mass stars explode in a supernova leaving behind a neutron star, pulsar, black hole, or nothing.





Black Holes (Chapter 14-1 to 14-5)





Pg. 404 # 1 - 3, 5, 7, 9, 17, 19, 23, 28.

Attachments

figure_12_20.jpg