Ch. 9 Measuring the STARS

I. Parallax & Proper Motion

 A. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is used to find

 distances to the *\_\_\_\_\_\_\_\_\_\_\_\_\_\_* stars

 B. *Hipparcos –* measured distances to

 over 1 \_\_\_\_\_\_\_\_\_ stars within \_\_\_\_\_ l.y.

 C. **Parsecs**

 1. The \_\_\_\_\_\_\_\_\_\_\_\_ to a star which

 shows a parallax shift of 1 \_\_\_\_ \_\_\_\_

 2. 1 parsec (pc) ≈ \_\_\_\_\_ light years

Parallax Example Problems

 1. How far away is \*Alpha Centauri in

 parsecs at 4.3 light years away?

 2. If a star has a parallax of .02”…

 a. How far away is it in parsecs?

 b. In light years?

 3. How far away (in l.y.) is a star

 with a parallax shift of .025”?

 D. **Proper Motion**

 1. The annual \_\_\_\_\_\_\_\_\_\_ movement of

 a star across the sky is called its

 proper motion.

 2. This is not its \_\_\_\_\_\_ motion – only

 the \_\_\_\_\_\_\_\_\_\_\_ part (not radial part)

 Ex/ \_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_ (10” / yr. )

II. Brightness

 A. **Luminosity**: \_\_\_\_\_\_ energy radiated

 by a star each second at all λ’s.

 1. a.k.a. **Absolute brightness**

 2. Intrinsic property independent of

 a star’s location or observer’s motion.

 Ex/

 B. **Apparent brightness**: Amount of

 energy per area per unit time

 hitting Earth.

 i.e. How bright it appears

 1. Depends on star’s \_\_\_\_\_\_\_\_\_\_ from us

 2. Obeys the \_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_

 Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 C. **The Magnitude Scale**

 1. Ranking of \_\_\_\_\_\_\_\_\_\_\_\_

 2. Started by *Hipparchus* -\_ categories

 3. Lower #’s = brighter objects

 4. Each level \_\_\_\_\_ x brighter. 2.5x

 Ex/ Betelgeuse (\_\_\_), Polaris (\_\_\_\_)

 5. Can be \_\_\_\_\_\_\_\_\_\_\_\_

 Ex/Sirius (\_\_\_\_\_), Venus (\_\_\_\_\_\_)

 Moon( ),\*Sun ( )

 6. Naked eye limit: (\_); Binoculars( )

 7. **Absolute magnitude**: The star’s

 apparent magnitude from a

 distance of \_\_\_ parsecs. ~\_\_\_ light yr

 a. Distance “ \_\_\_\_\_\_\_\_\_\_\_\_”

 b. Ex/ The Sun (\* \_\_\_\_\_\_ )

Brightness Practice Problems

 1. How much brighter is a magnitude

 3 star than a magnitude 10?

 2. A star 10 light years away is

 magnitude 2. How far away is a

 similar star (same luminosity) that

 is only a magnitude 5?

III. Stellar Temperatures & Sizes

 A. **Blackbody curves**

 1. Used to find a star’s \_\_\_\_\_\_\_\_\_\_\_\_\_

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (& color)

 2. The \_\_\_\_\_\_\_\_ of the curve stays same

 B. **Spectral Types**

 1. Based on a star’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 2. O.B.A.F.G.K.M.

 Hot ⇒⇒ Cool (\*10 subdivisions)

 Ex/ Sun (\_\_\_\_); Vega (\_\_\_\_\_);

 Betelgeuse (\_\_\_\_\_)

 C. Stellar Sizes

 1. \_\_\_\_\_\_\_: Stars 10-100x the radius of

 the Sun. Ex/Arcturus (\_\_\_ RSUN)

 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ : Stars > 100 RSUN

Ex/ Betelgeuse (~ \_\_\_\_\_ RSUN)

 3. \_\_\_\_\_\_\_\_ : Stars < radius of the \_\_\_\_\_

 Ex/ Sirius B (.01 RS  \_\_\_\_\_\_\_ dwarf)

 Proxima Centauri (\_\_\_\_\_\_ dwarf)

IV. The H-R Diagram

A. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ vs \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

B. Usually, hot stars are \_\_\_\_\_\_\_\_\_\_\_\_\_.

 These are found on the

 **MAIN SEQUENCE** of the H-R

 1. Upper left: \_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_

 2. Lower right: \_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_

 3. Stars ~.1 - 10 rSUN; .01-100 \*MSUN

C. Exceptions to the rule:

 a. \_\_\_\_\_ \_\_\_\_\_\_\_\_\_ region (Cool, bright)

 b. \_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_ region (Hot, dim)

V. SPECTROSCOPY - An analysis of

 the way atoms absorb & emit light.

 A. Spectroscopes

1. Barrier w/ narrow slit creates beam of light
2. A prism or \_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_ separates light into colors.

 a. Grating - Transparent sheet w/close, parallel lines

 b. Light diffracts thru the openings - rainbow forms

 Ex/

 3. Eyepiece for viewing

 4. Spectrographs/Spectrometers

 B. **KIRCHOFF’S LAWS**

 1. German Gustav Kirchoff (1860)

 Listed \_\_\_ rules of spectroscopy

 2. \_\_\_\_\_\_\_\_, liquids, & dense gases emit

 all wavelengths of light - a

 **continuous spectrum**.

 a. Full, smooth \_\_\_\_\_\_\_\_\_\_\_\_\_

 b. Humans can see \_\_\_\_\_- \_\_\_\_\_ nm

 Ex/

 3.**Emission Spectrum**: a low density,

 “\_\_\_\_\_” gas produces emission lines

 characteristic of that gas.

 a. Narrow, colored lines produced

 b. Always the \_\_\_\_\_\_\_ lines for a

 particular \_\_\_\_\_\_\_\_\_\_\_\_\_\_

 c. Like a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ for materials

 d. Can be used for solids/liquids

 e. Pattern - emission spectrum

 Ex/ \_\_\_\_\_\_ sign, \_\_\_\_\_\_ nebula, \_\_\_\_\_\_\_\_\_

 4. **Absorption Lines**: A \_\_\_\_\_, thin gas

 absorbs certain wavelengths,

 produce absorption lines

 characteristic of that gas.

 a. Narrow, \_\_\_\_\_\_\_ lines

 b. Darkest called \_\_\_\_\_\_\_\_\_\_\_\_\_\_ lines

 c. Can be produced in a lab

 d. Appear in the same position as the

 corresponding \_\_\_\_\_\_\_\_\_\_\_\_\_ lines

 e. Produced in space by interstellar

 \_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_, & \_\_\_\_\_\_\_\_\_\_\_\_

 5. Astronomy Applications

 a. Kirchoff & \_\_\_\_\_\_\_\_\_\_ - spectral lines

 are associated w/ *known* elements

 such as \_\_\_\_\_\_\_\_\_\_\_\_\_

 b. In 1868, a previously unknown

 element was named after the Sun-

 C. Formation of Spectral Lines

 1. Electrons only exist at certain

 energy \_\_\_\_\_\_\_\_ or shells

 2. Electrons may be “\_\_\_\_\_\_\_\_\_\_” to a

 higher level by heat, elec., etc..

 3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ is released when

 electrons “\_\_\_\_\_” from this excited

 state back to their ground state

 4. The size of the energy “\_\_\_\_\_\_”

 directly determines the *type* of

 radiation given off - E = hf

 5. Molecules also emit radiation due to

 \_\_\_\_\_\_\_\_\_\_ (Infra) or \_\_\_\_\_\_\_\_\_ (Radio)

 D. Spectral line analysis

 1. Spectral Line Strength (\_\_\_\_\_\_\_\_\_\_)

 (Brightness or darkness of lines)

 a. \_\_\_\_\_\_\_\_\_\_ of atoms of each element

 b. Temperature info as well

 i. H2 lines of the “\_\_\_\_\_\_” Sun are

 weak – they’re not excited

 ii. Really \_\_\_\_ stars - no H2 lines at all

 - electrons have been stripped

 2. The **Doppler Effect**

 a. \_\_\_\_\_\_\_\_\_\_ spectral lines of stars, etc..

 b. Used to calculate **radial velocity**

 (along our \_\_\_\_\_\_\_ of \_\_\_\_\_\_\_\_\_\_)

 c. \_\_\_\_\_\_\_\_\_ shift or \_\_\_\_\_\_ shift

 Ex/ 420 to 425 nm



 3. Broadening of spectral lines

 a. Caused by \_\_\_\_\_\_\_\_\_\_ Effect

 b. \_\_\_\_\_\_\_ move toward & away

 c. Turbulence of \_\_\_\_\_ (swirling)

 d. \_\_\_\_\_\_\_\_\_\_\_\_\_ of star, galaxy, etc..

v = f **λ**

**velcocity = freq. x wavelength**

4. **Zeeman Effect**: Presence of strong

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_ can split lines.

 

 Doppler Example Problem

 The 486 nm Hβline of a star is

 received at 485 nm.

 a. Has it been red- or blue-shifted?

 b. What is the frequency of the

 *original* Hβ line?

 c. What is the frequency of the

 *detected* Hβline?

 d. Is it approaching or receding?

Extra Example Problems

1. At what *peak wavelength* does a star

with a surface temp. of 5000K radiate?

2. Two otherwise identical bodies have

 temperatures of 2,000 K and 16,000 K.

 a. Which radiates the most energy?

 b. How much more energy?