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**

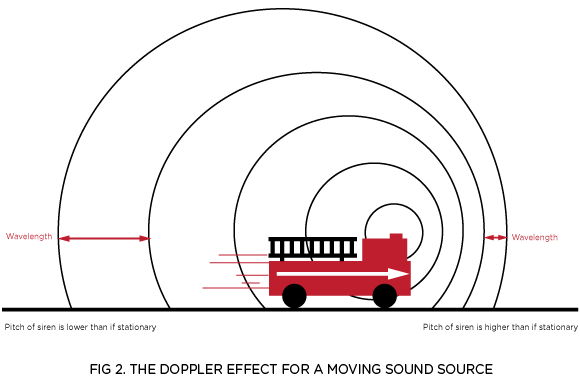
a. \_\_\_\_\_\_\_\_\_\_ spectral lines of stars, etc..

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)

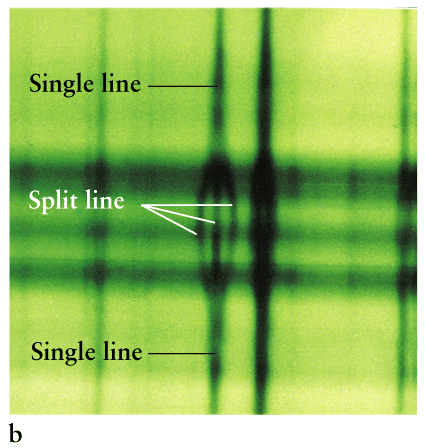
d. \_\_\_\_\_\_\_\_\_\_\_\_\_ of star, galaxy, etc..

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?