**Ch. 3 TELESCOPES**

INTRO: In astronomy, \_\_\_\_\_\_\_\_\_\_\_\_ usually precedes \_\_\_\_\_\_\_\_\_\_\_\_.

 Ex/ New solar systems;

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ universe

Telescopes have grown in \_\_\_\_\_\_ and complexity and now cover the entire \_\_\_\_ spectrum.

I. Optical Telescopes (Sec 3.1)

 A. Telescope: A “\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_”

 used to capture incoming photons

 & concentrate them into a focused

 beam for analysis.

 B. Types of Telescopes

 1. \_\_\_\_\_\_\_\_\_\_\_\_\_: A glass \_\_\_\_\_\_\_ bends

 (refracts) incoming light rays to a

 focus. Eyepiece

 magnifies. Ex/ \_\_\_\_\_\_\_\_ Observatory

 2. \_\_\_\_\_\_\_\_\_\_\_: A curved \_\_\_\_\_\_\_\_\_\_\_\_

 (primary mirror) reflects incoming

 rays to a focus. Eyepiece magnifies.

 C. Reflector Design

 1.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: Secondary mirror

 reflects light to an eyepiece on the

 \_\_\_\_\_\_\_\_ of the telescope.

 Subcategory: Dobsonian

 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: Secondary mirror

 reflects light back through a hole

 in the primary mirror.

II. Telescope Size (Sec 3.2)

 A. Light-gathering power:

Larger collecting area = \_\_\_\_\_\_\_\_ image.

 1. Brightness ~ \_\_\_\_\_\_\_\_\_\_\_\_\_\_2

 Ex/ 10” aperture is \_\_\_\_ x brighter than a 2” (*or* 25 x\_\_\_\_\_\_\_\_\_\_ exposure)

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

Example Problem: How long would it take a telescope with a 9” aperture to produce the same image that a 3” scope can make in 45 min.?

 2. Largest: \_\_\_\_\_ in Chile (16.4 m)

 \_\_\_\_\_\_ I & II in Hawaii (13.7 m)

 GMT (2016); TMT (2018); ELT (?)

 B. **Resolving Power**: Ability to make

 \_\_\_\_\_\_\_\_ images of faint objects or

 to distinguish between 2 adjacent

 objects in the sky.\*\*

 aka **Angular \_\_\_\_\_\_\_\_\_\_\_\_\_\_**

III. High Resolution Astronomy

 (Sec 3.3)

 A. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ Blurring

 1. Hinders \_\_\_\_\_\_\_\_\_\_\_-based scopes

 Ex/ “twinkling” stars

 2. Best locations- \_\_\_\_\_\_, \_\_\_\_\_\_, & \_\_\_\_\_

 Ex/ Chile, Hawaii, Arizona

 3. Another solution - \_\_\_\_\_\_\_\_\_.

 Ex/Hubble (1993) - \_\_\_ x better

 B. \_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_: Mirror

 changes \_\_\_\_\_\_\_\_ to compensate for

 the blurriness of the \_\_\_\_\_\_\_\_\_\_\_\_\_.

 a. \_\_\_\_\_\_\_\_\_ pierce atmosphere,

 create “artificial star”

 b. Some now sharper than Hubble!

 Ex/ Keck, VLT

IV. Radio Astronomy (Sec 3.4)

 A. Radio telescopes

 1. Only since the 1950’s

 2. Pioneers- Karl \_\_\_\_\_\_\_, Grote Reber

 3. Curved metal dish focuses radio

 waves to a \_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_.

 4. Instruments located at \_\_\_\_\_\_ \_\_\_\_\_.

 B. Large Size Necessary

 1. Signals are \_\_\_\_\_\_\_\_\_ from space.

 2. Long wavelength radio \_\_\_\_\_\_\_\_\_

 greatly – poor resolution

 a. Surface doesn’t have to be \_\_\_\_\_\_\_\_

 b. It’s \_\_\_\_\_\_\_ to make them large!

 Ex/ Largest: \_\_\_\_\_\_\_\_\_\_\_ – 1000 ft.

 wide! (305 m)

 C. Value of Radio Astronomy

 1. Can be done during the \_\_\_\_\_\_\_\_\_\_\_.

 2. Pierces clouds, rain, snow.

 3. Objects *visibly* \_\_\_\_ may be

 strong *radio* sources. Ex/

 \*4. Radio penetrates \_\_\_\_\_\_\_\_\_ in space

 Ex/ Center of \_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_

V. INTERFEROMETRY (Sec 3.5)

 A. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: Data from 2 or

 more scopes combined. Ex/ \_\_\_\_\_\_

 in N. Mex (27 dishes); ATA- 42

 (2007) \_\_\_\_\_\_\_ – 66 (2012); Square

 Kilometer Array- 150 (2020)

 B. Behaves like a single dish whose diameter is the \_\_\_\_\_\_\_ between dishes.

 Largest Telescopes 201\_\_

 Refractor: \_\_\_\_\_\_\_\_\_\_\_\_\_ - \_\_ m

 Single mirror: \_\_\_\_\_\_\_\_\_\_\_\_\_ -10.4 m

 Optical interferometer: \_\_\_\_\_\_-16.4 m

 Single Radio Dish: \_\_\_\_\_\_\_\_\_\_ -305 m

 Radio Array: \_\_\_\_\_\_\_\_ -66 dishes

 ATA – 42 dishes; \_\_\_\_\_ -27 dishes

VI. SPACE-BASED TELESCOPES

 (Sec 3.6)

 A. Microwave satellites

 1. COBE (1990’s) - Measured the

 \_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_ - proof

 of the \_\_\_\_ \_\_\_\_\_\_!

 2. \_\_\_\_\_\_\_\_\_ (2009)

 B. INFRARED Astronomy

 1. Long wavelength IR penetrates

 \_\_\_\_\_\_\_\_ in space.

 2. Good for \_\_\_\_\_ or \_\_\_\_\_\_\_-forming

 clouds of warm dust & gas.

 3. Mountaintops may be used. Ex/

 4. Airplanes may be used. Ex/

 5. Or Space-based telescopes. Ex/

 \_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_ Space Tel. (201?)

 ~ 6.5 m- “Successor to the \_\_\_\_\_\_\_\_\_\_”

 C. VISIBLE light

 1. The \_\_\_\_\_\_\_\_\_ Space Telescope

 2.\_\_\_\_\_\_\_\_\_\_ aberration corrected-‘93.

 3. Final repair mission in 2009.

 D. ULTRAVIOLET Astronomy

 1. Used for \_\_\_\_\_\_\_ stars.

 2. Can be done by high-altitude

 \_\_\_\_\_\_\_\_\_\_\_\_.

 3. Or by satellites. Ex/ Galex, Hubble

 E. X-RAY Astronomy

 1. No \_\_\_\_\_\_\_\_\_observations - only

 satellites

 2. Emitted from \_\_\_\_\_\_\_\_\_\_ events.

 Ex/

 3. Special design (difficult to focus)

 Ex/ \_\_\_\_\_\_\_\_\_\_\_ (1990’s)

 F. GAMMA RAY Astronomy

 1. Can’t be \_\_\_\_\_\_\_\_\_.

 2. Counted by special detectors

 3. \_\_\_\_\_\_\_\_\_\_\_ (~ 1 detection per day)

 4. Occasional “bursts”, or \_\_\_\_\_\_\_’s.

 a. \_\_\_\_\_\_\_\_\_\_\_\_ – *really* massive star

 explodes, forming a \_\_\_\_\_\_\_ \_\_\_\_\_\_\_!

 b. Colliding binary \_\_\_\_\_\_\_\_\_ stars

 5. Compton Gamma Ray Obs (2000)

 6. Swift (2004)

 7. \_\_\_\_\_\_ Gamma Ray Observatory-07