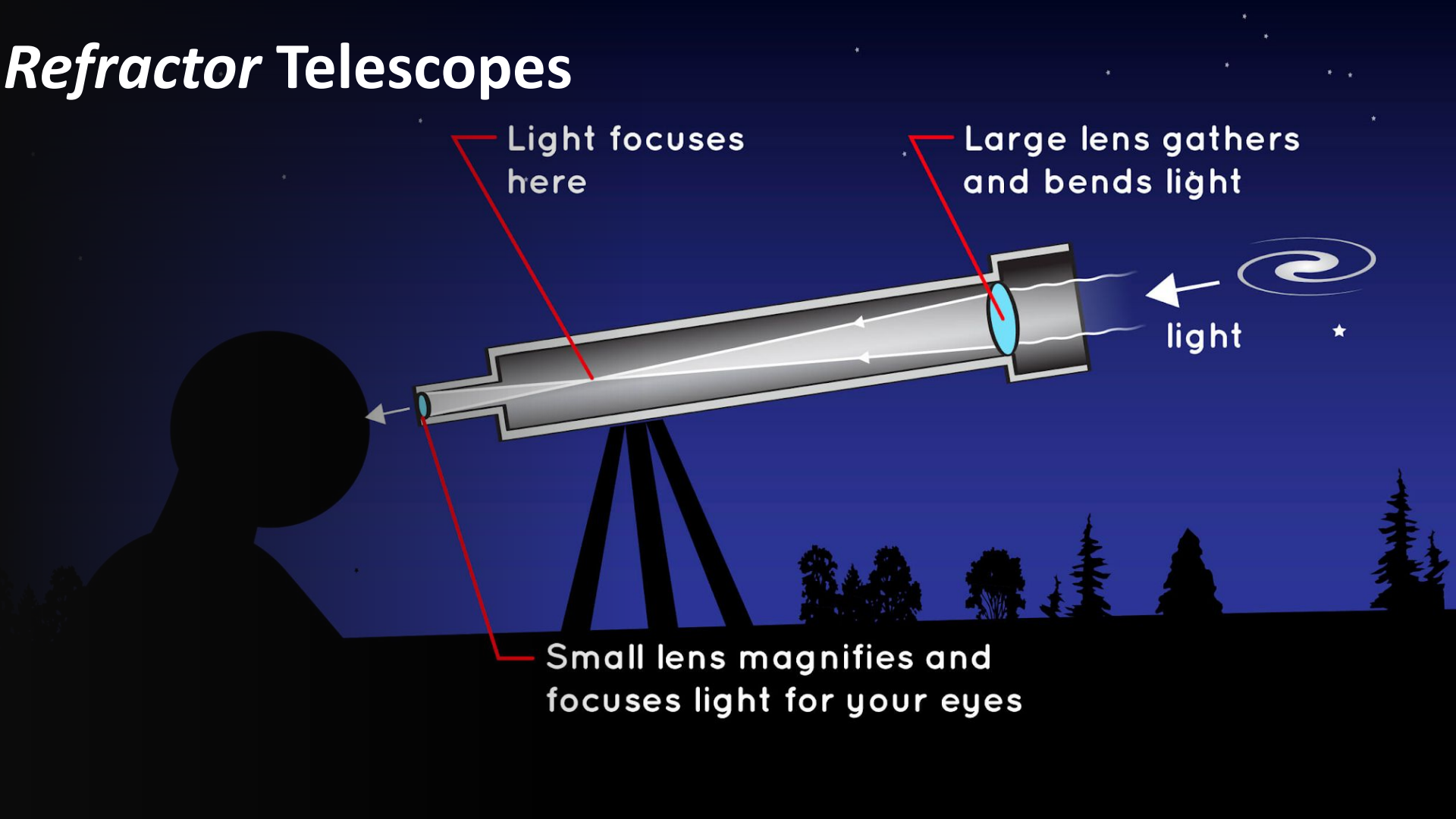
Announcements

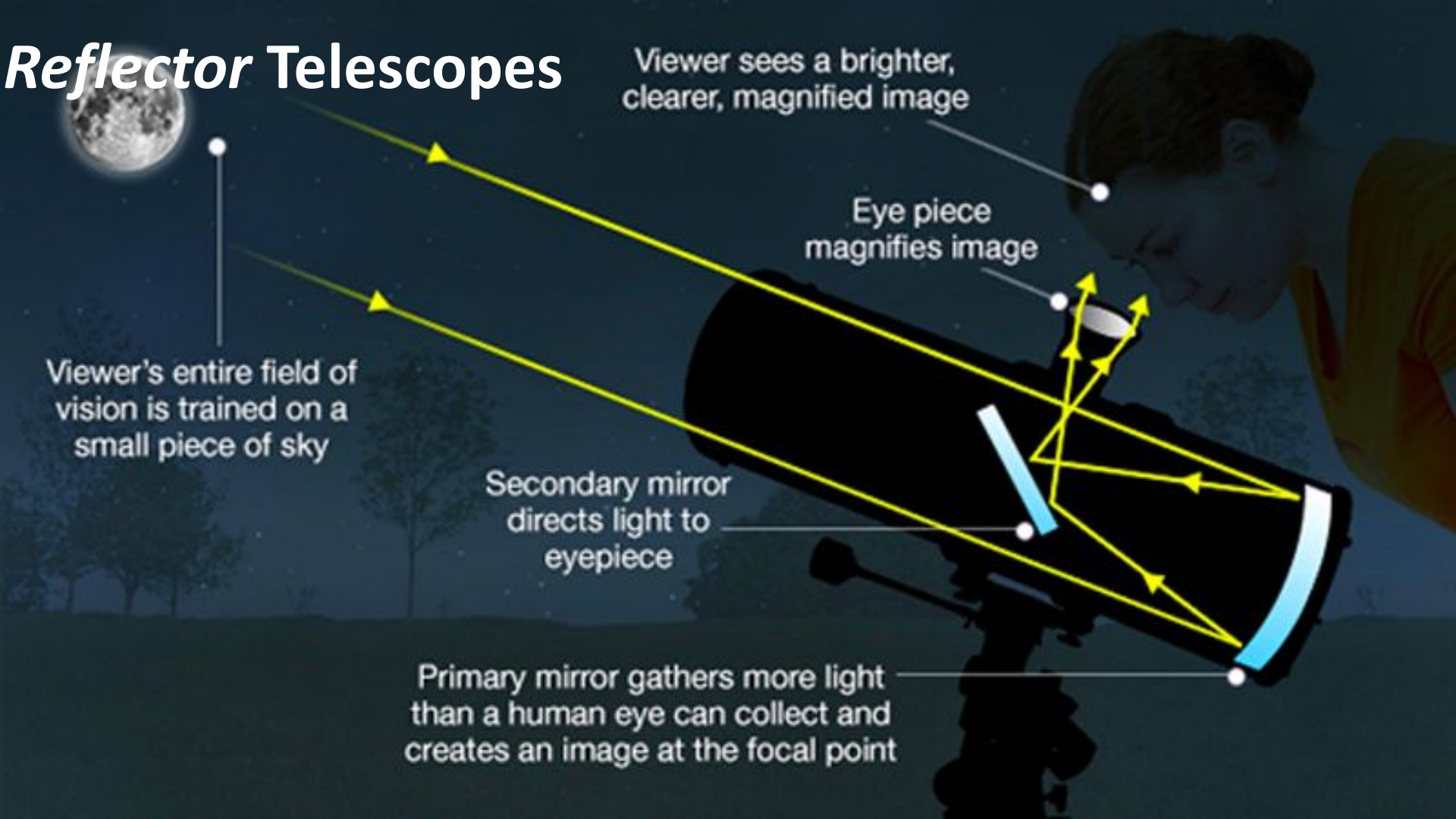
- Lab 4 is graded
- Next week is again a night lab
  - We will ***not*** be meeting in our normal classroom - instead we will meet in the lobby of ISTB4
    - 7:30 P.M.
- Note that the quiz for this week includes a question that requires manual grading
  - Canvas will automatically assume it is 0 points until I grade it…
    - I don’t like that Canvas does this, but I cannot change it
    - So don’t panic that you can’t get above a 26/30 - I will grade the question within a couple days

Intro To Telescopes

Refractor Telescopes



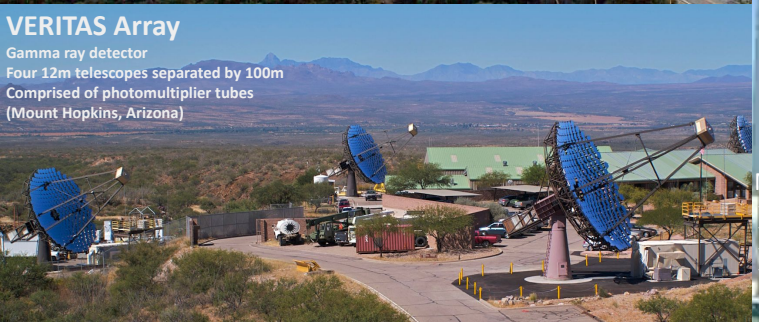
Reflector Telescopes



Telescopes in Arizona

- Telescopes work best with dry atmospheres, clear skies, and high altitudes
  - Arizona has quite a lot of those

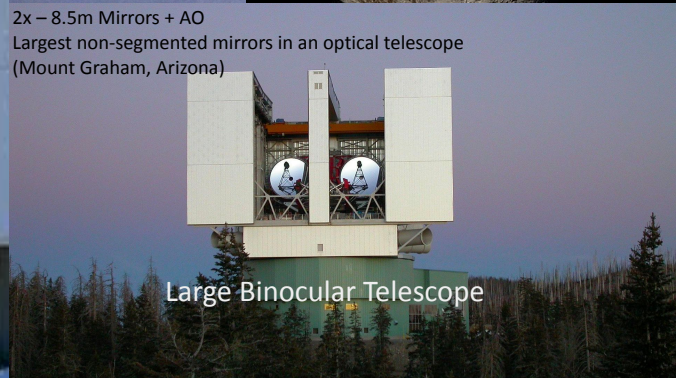
Kitt Peak
First telescope to search for near-earth asteroids
Dark matter, cosmic distances, high-redshift galaxies
(Kitt Peak, Arizona – 1 hr SE of Tucson)



VERITAS Array
Gamma ray detector
Four 12m telescopes separated by 100m
Comprised of photomultiplier tubes
(Mount Hopkins, Arizona)

MMT (Multi Mirror Telescope)
- 6.5m mirror + AO
- 9.6m focal length
- Pioneered AO systems
- (Mount Hopkins, Arizona)

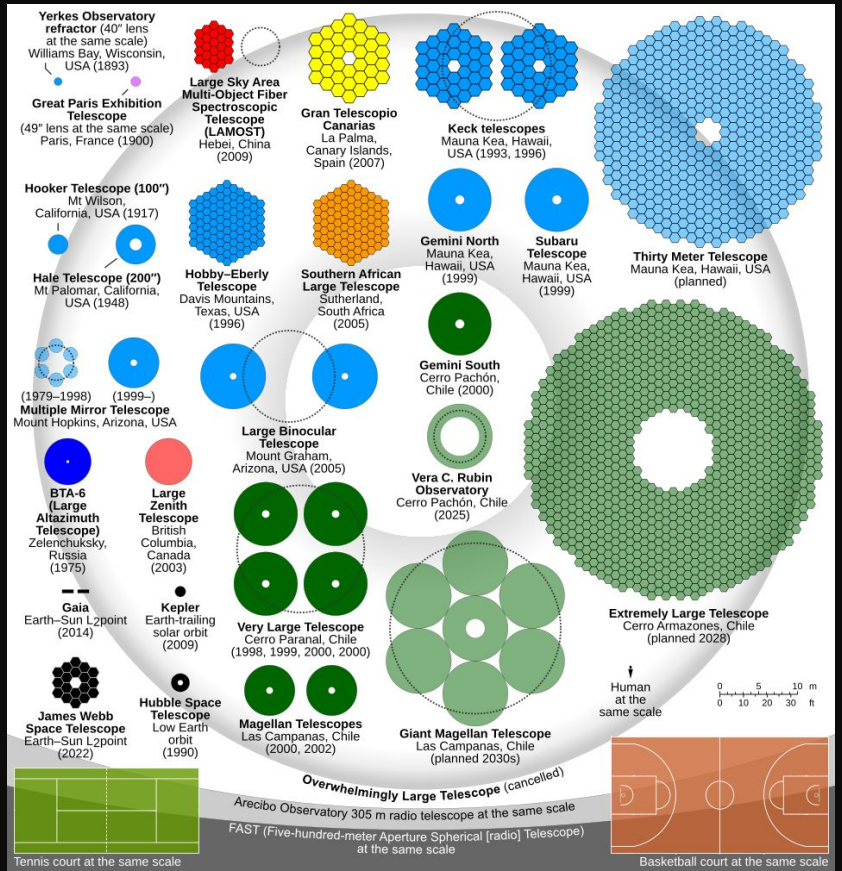
Lowell Observatory
- Est. 1894
- Discovered Pluto in 1930
- Four research telescopes (<4.5m)
- (Flagstaff, Arizona)



2x – 8.5m Mirrors + AO
Largest non-segmented mirrors in an optical telescope
(Mount Graham, Arizona)

Large Binocular Telescope

Some (Other) Important Locations



Some (Other) Important Locations

- Hawaii (Mauna Kea)
  - Keck Observatory
  - Two telescopes, tied with each other and another in Texas for third largest mirror

Some (Other) Important Locations

- Spain (Canary Islands)
  - Gran Telescopio Canarias
    - Current largest mirror

Some (Other) Important Locations

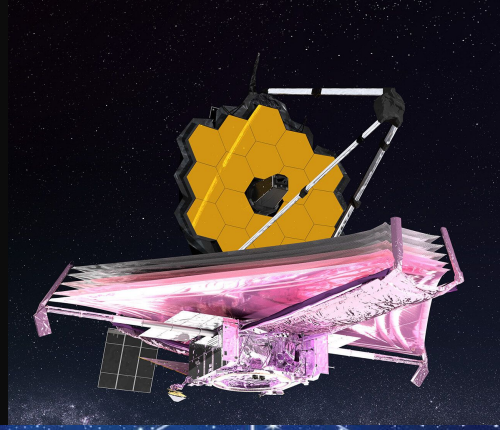
- Chile (Atacama Desert)
  - Vera Rubin (below)
    - Largest camera
  - ELT (Right)
    - Under Construction - New Largest Mirror
  - VLT (Not pictured)
    - Current largest total mirror area (4 mirrors combined)

Some (Other) Important Locations

Image Credit: https://tenor.com/search/tim-curry-space-gifs

Some (Other) Important Locations

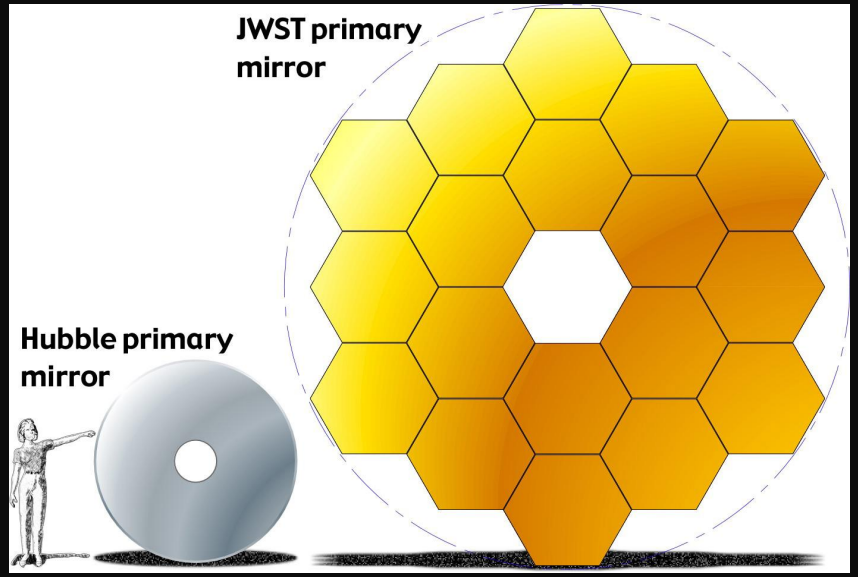
- Space (Various Orbits)
  - JWST (Right)
  - HST (Left)



Properties of a Telescope: Light Gathering Power

- AKA Area
- The bigger the area of the mirror or lens, the more light it collects
- Think about a bucket gathering rain water

$$A = \pi \left(\frac{D}{2}\right)^2$$



Mirror Diameters:
Hubble: 2.4m
JWST: 6.5m

Properties of a Telescope: Focal Length and Magnification

- Focal length = distance between optic device (mirror, lens) and where we see image
  - ASU telescopes: f = 2000 mm
    - Eyepieces: f = 18, 24, and 40 mm
- More magnification means a dimmer image

$$Magnification = \frac{Telescope\ Focal\ Length}{Eyepiece\ Focal\ Length}$$

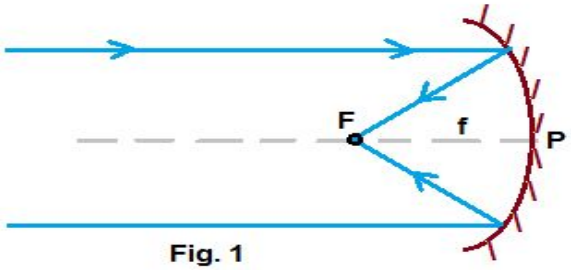
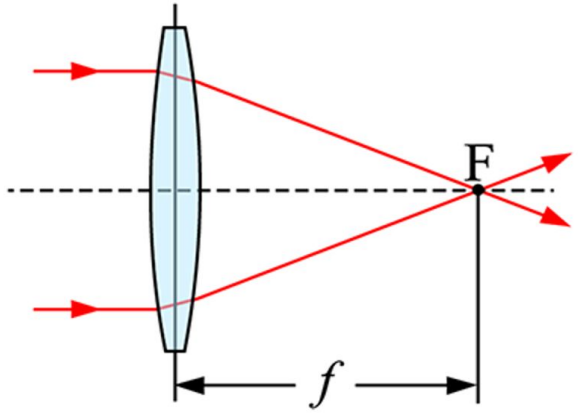
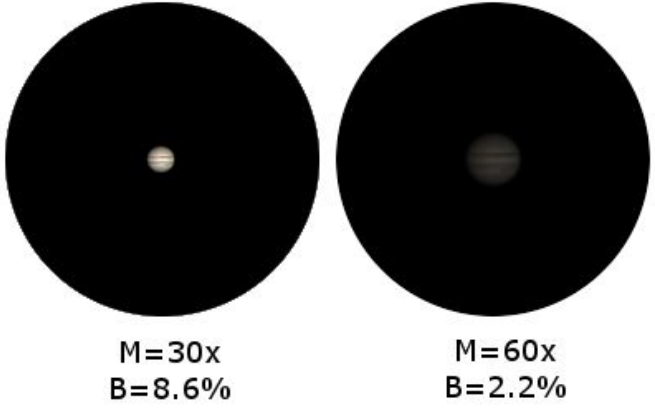


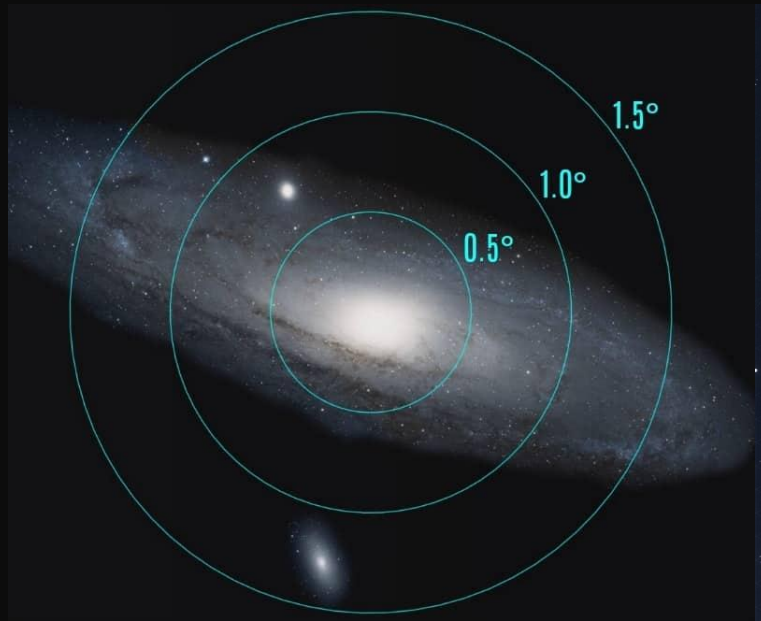
Fig. 1

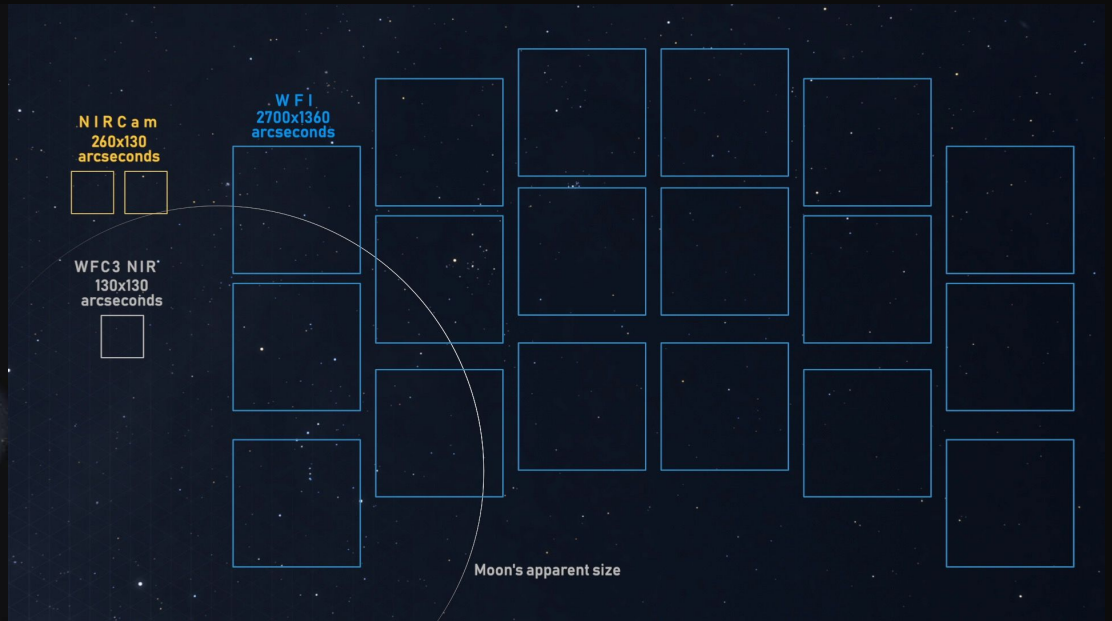




Properties of a Telescope: Field of View

- Angular size of the piece of sky visible through a telescope (degrees, ‘, “)
- FOV dependent on magnification
  - Greater focal length = greater field of view





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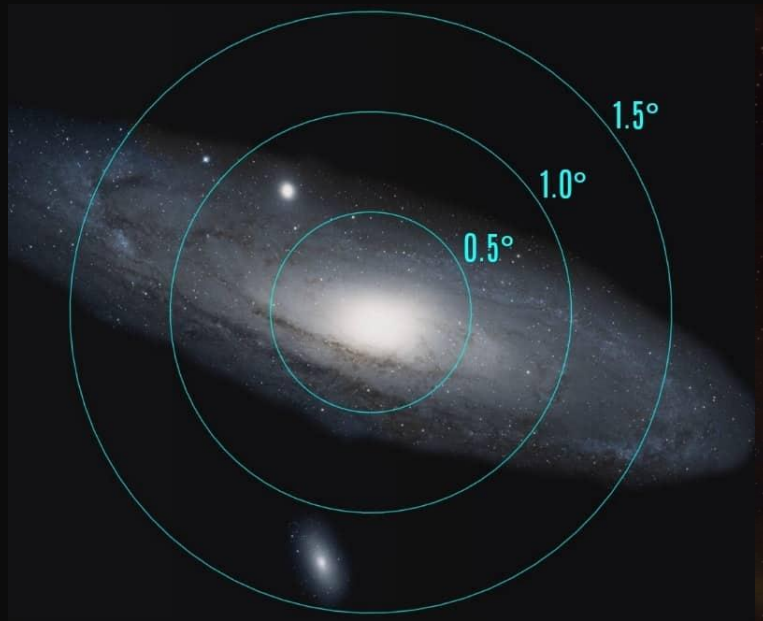
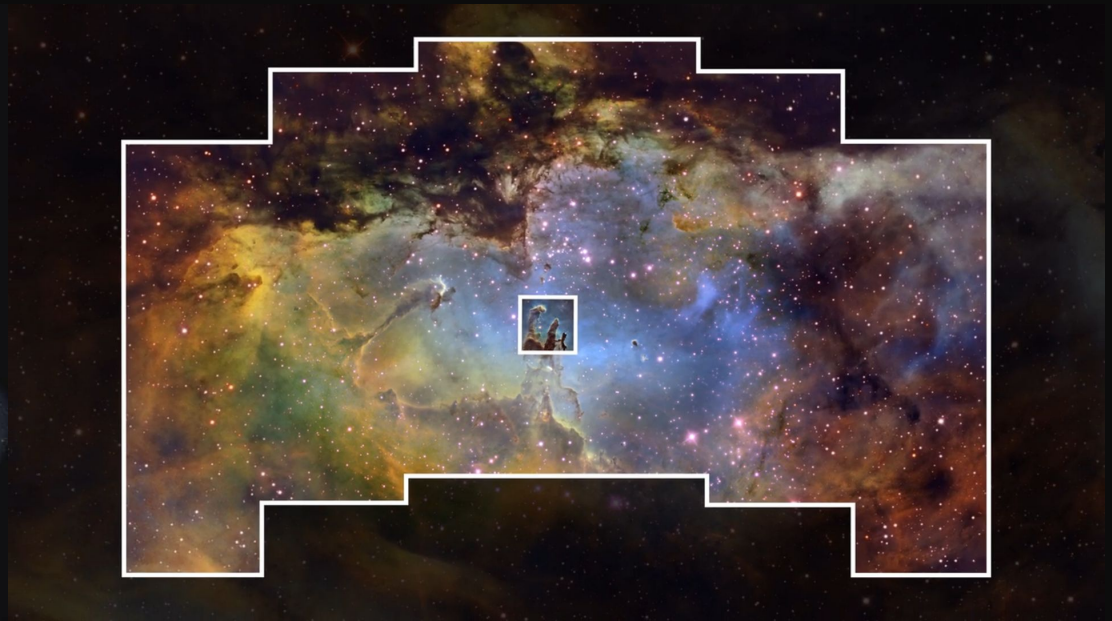
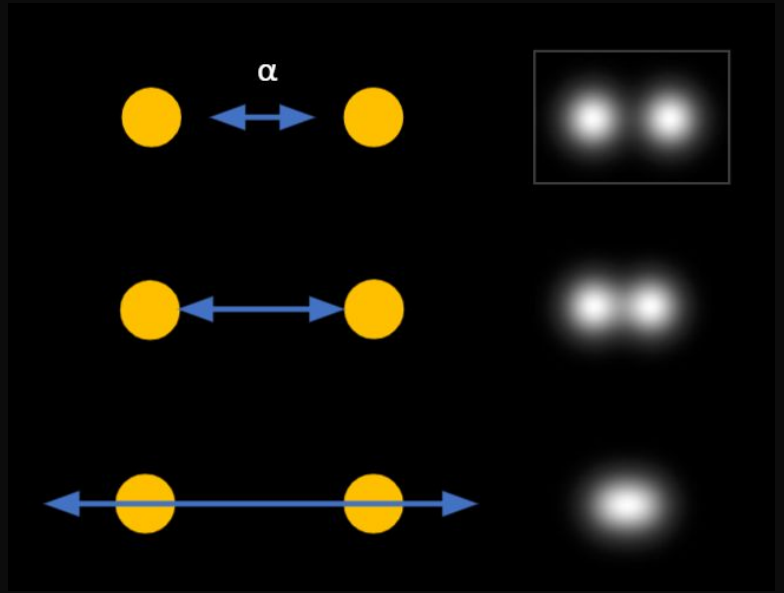




Properties of a Telescope: Resolving Power

- The resolving power (also called angular resolution) is the ability of a telescope to separate two close objects or to see fine detail in an image
- Resolving Power = Minimum distance that two objects can be separated and you can still see them as two different objects



$$\alpha = \frac{4.56}{D},$$

(Dawes limit for a human eye through a telescope eyepiece)
D = diameter of primary mirror in telescope in inches
α = angular separation between objects in arcseconds

Properties of a Telescope: Scale

- Tells us how large an object would appear if you were to photograph it with a telescope
- Dependent on the focal length of primary mirror
- Units: angle/length
  - Usually either degrees/mm (°/mm) or arcseconds/mm (“/mm)

$$\text{scale} = \frac{\text{angular size of an object on the sky}}{\text{size of the final image using the telescope}}$$

ASU’s Celestron Telescopes

- 8-inch primary mirror
- 2000mm focal length
- Eyepiece focal length varies
    - We will have a sign on each telescope with the eyepiece focal length

Note: These are not in use, the orientation will be different on the roof. Additionally, not all of the telescopes have a Telrad.

Today

- We are going to watch a few videos to fill in the table on page 7
  - Skip questions 1, 2, and 5
- Then up to the roof

Stop! Roof Stuff After This

Roof Rules

- Bring your stuff with you
  - We will not be coming back to the classroom
- Do not leave the walled in area
- Red flashlights only
  - No white lights except in emergencies
- Do not adjust the telescopes!
- We will be up there with one or more other classes
  - You can ask me or the other TA(s) if you have any questions
  - Lots of people
    - Take turns/work together, no need to do things in a specific order

Today (On the Roof)

- Observations
  - Since we are not using actual stars…
  - Page 8
    - Draw what you see
    - Remember to write down the eyepiece focal length
  - Page 10
    - Use relative brightness, (i.e. brighter or dimmer than other objects/other telescopes)
    - Answer the color based on what you see
    - Circle “Single Star” if you only see one object, circle “Double Star” if you see more than one
- Whenever the lab mentions finderscope or binoculars…
  - They are interchangeable for our purposes
- Question 14 and 15
  - Final units on 14 are inches
  - 15 is asking about the calculation in Question 14, not what we are observing today