

Chapter 6

Overview of Telescopes

Learning Goals Chapter 6

- **What are the two basic types of telescopes?**
- **How is data obtained and processed?**
- **Space vs. ground-based better and why?**



How does a telescope work?

- Telescopes collect light from far away objects
- Using lenses and mirrors the light is focused onto a small area
- The light is magnified with an eyepiece so you can see the object



Two types of telescopes

- There are two types of optical telescopes:

Refractor telescopes

Reflector telescopes

Refractor telescopes use lenses to focus objects

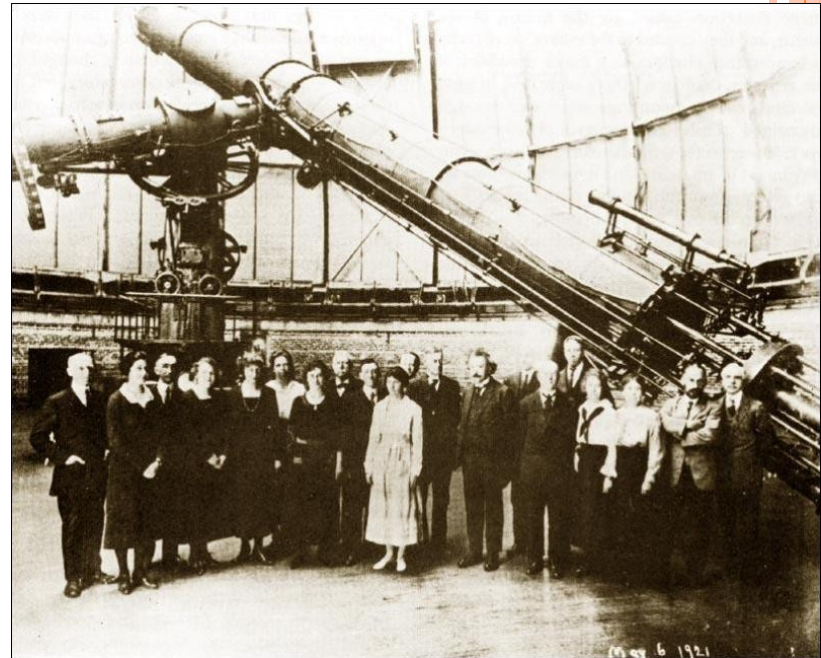
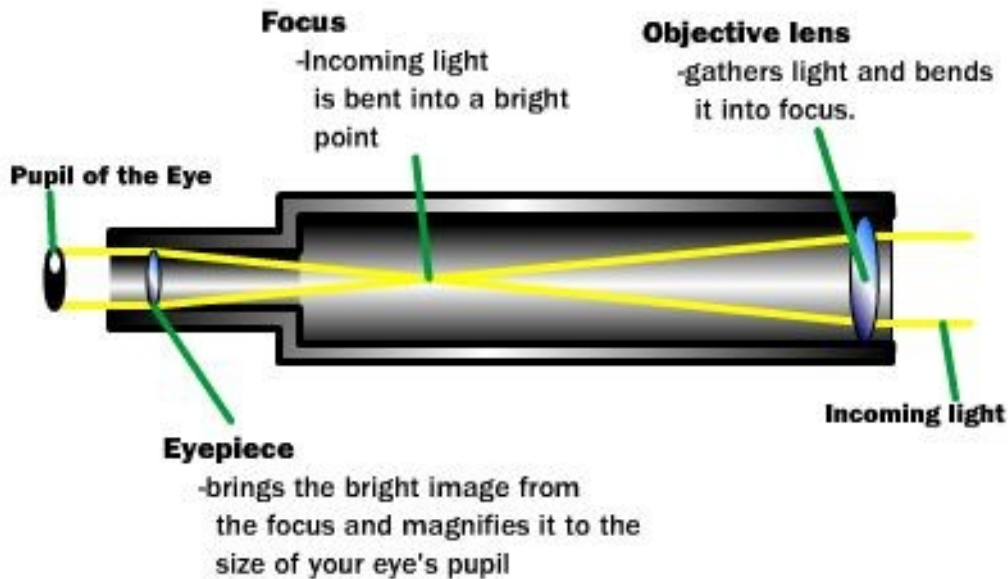
Reflector telescopes use lenses and mirrors to focus objects



Refractor telescopes

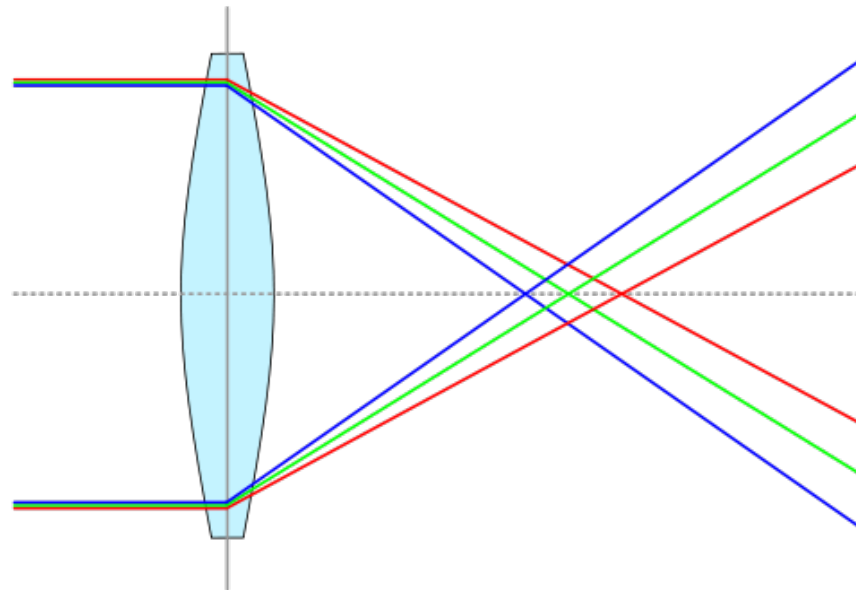
- Refracting telescopes are very long with heavy lenses

Refractor



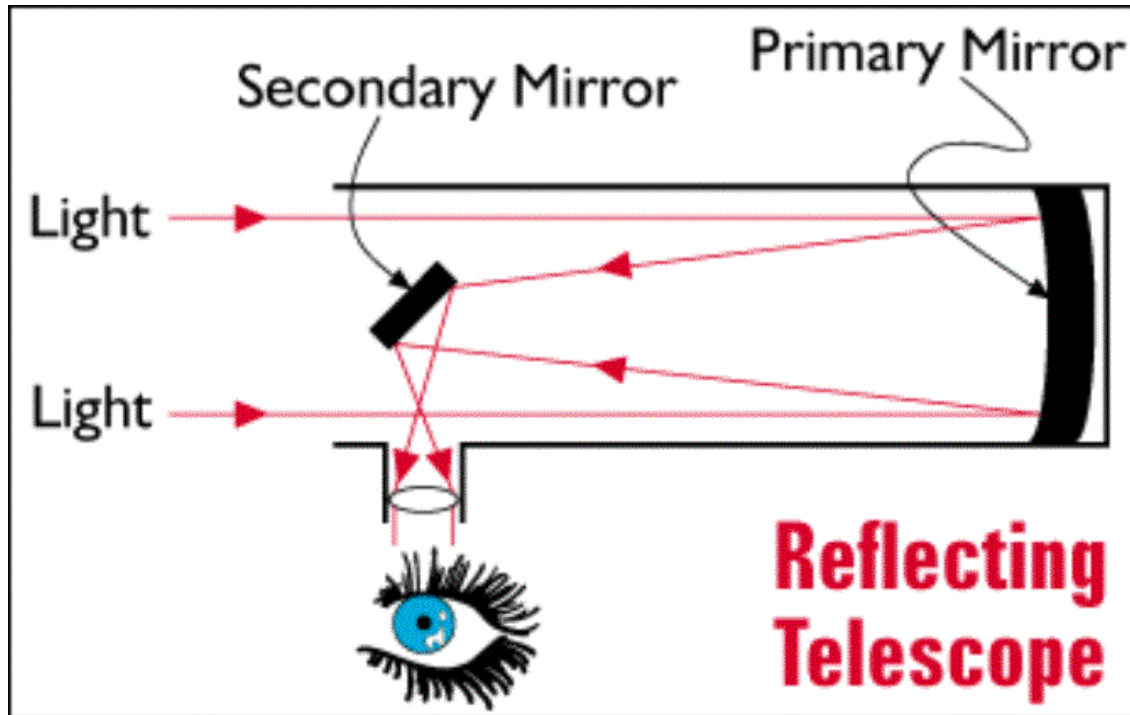
Chromatic Abberation

- The biggest problem with refracting telescopes is **chromatic aberration**
- Chromatic aberration occurs because different colors of light focus at different points



Reflector telescopes

- Reflecting telescopes use large mirrors to focus light
- Most modern telescopes are reflectors



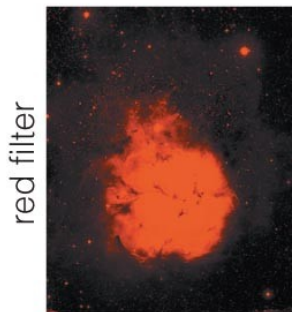
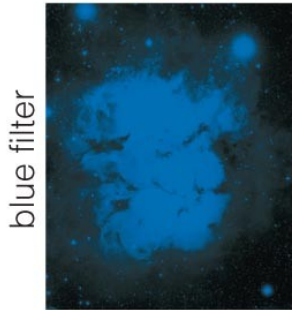
What do astronomers do with telescopes?

- **Imaging:** taking pictures of the sky
- **Spectroscopy:** breaking light into spectra
- **Time Monitoring:** measuring how light output varies with time



Imaging

The actual light collected ...



... is combined to show a full-color image.

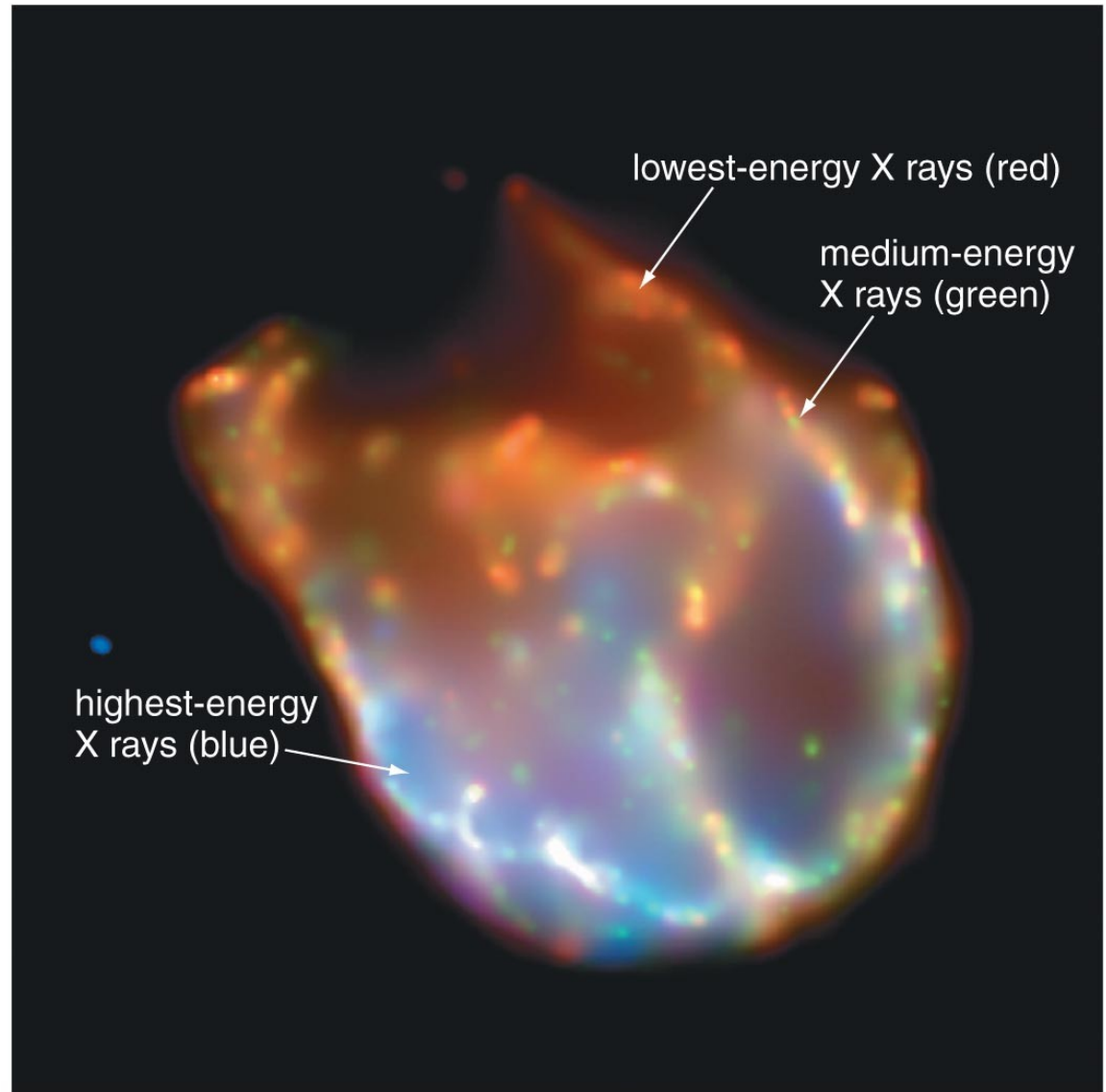


- Astronomical detectors generally record only one color of light at a time.
- Several images must be combined to make full-color pictures.
- LOTS of post processing occurs to make the images you see in magazines!

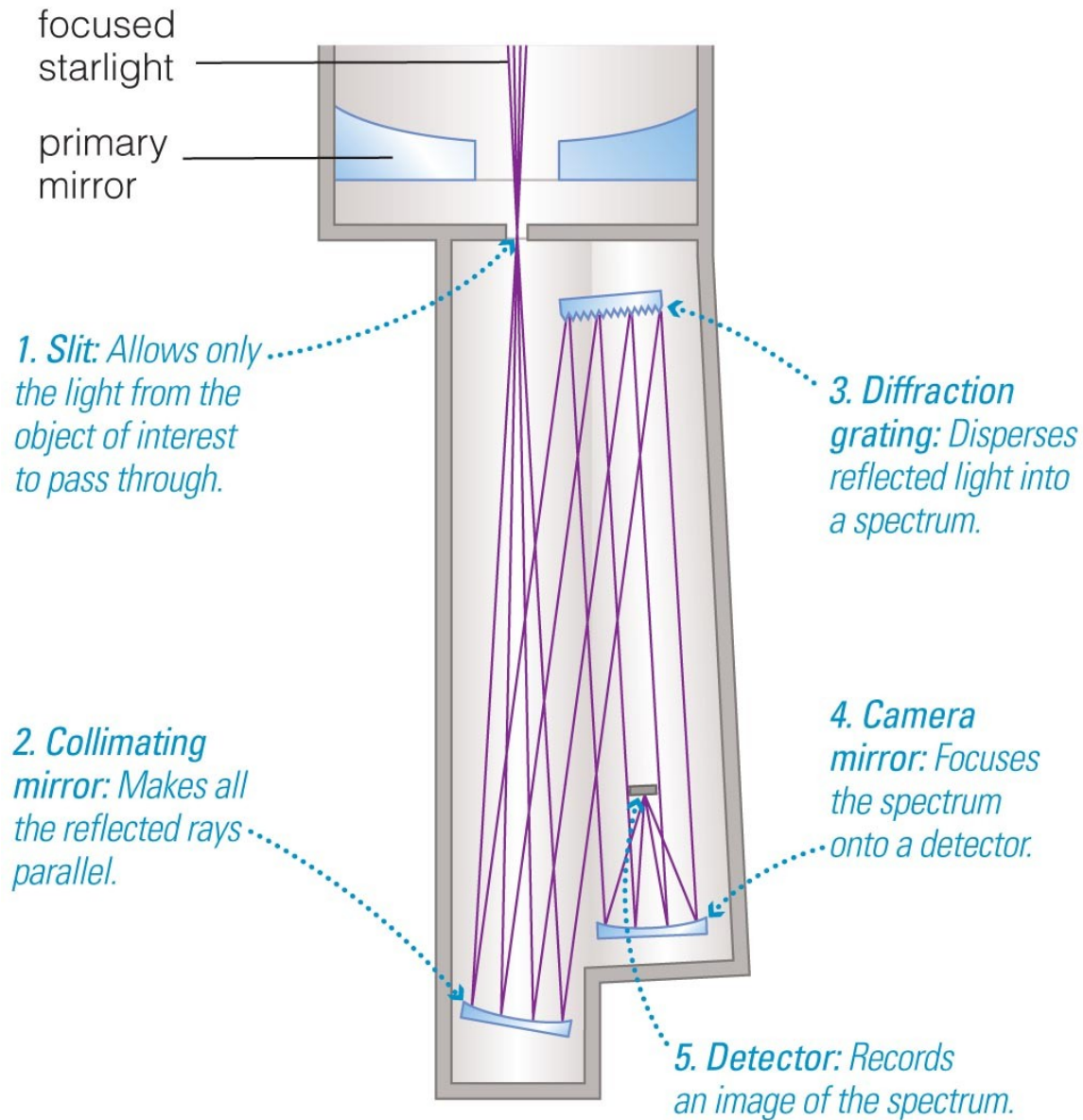


Imaging

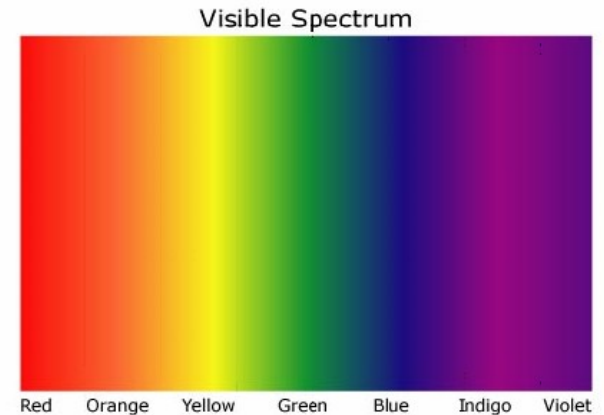
- Astronomical detectors can record forms of light our eyes can't see.
- Color is sometimes used to represent different energies of non-visible light.



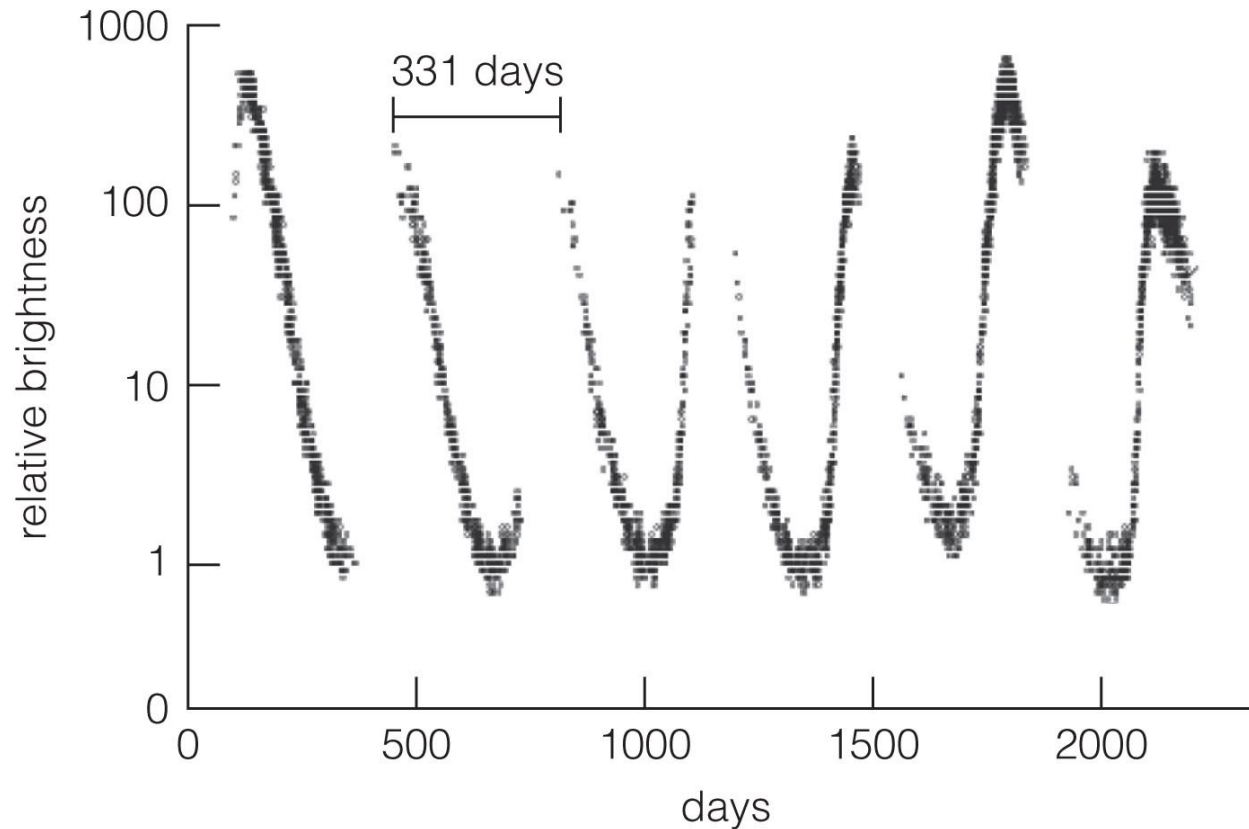
Spectroscopy



- A spectrograph separates the different wavelengths of light before they hit the detector



Time Monitoring

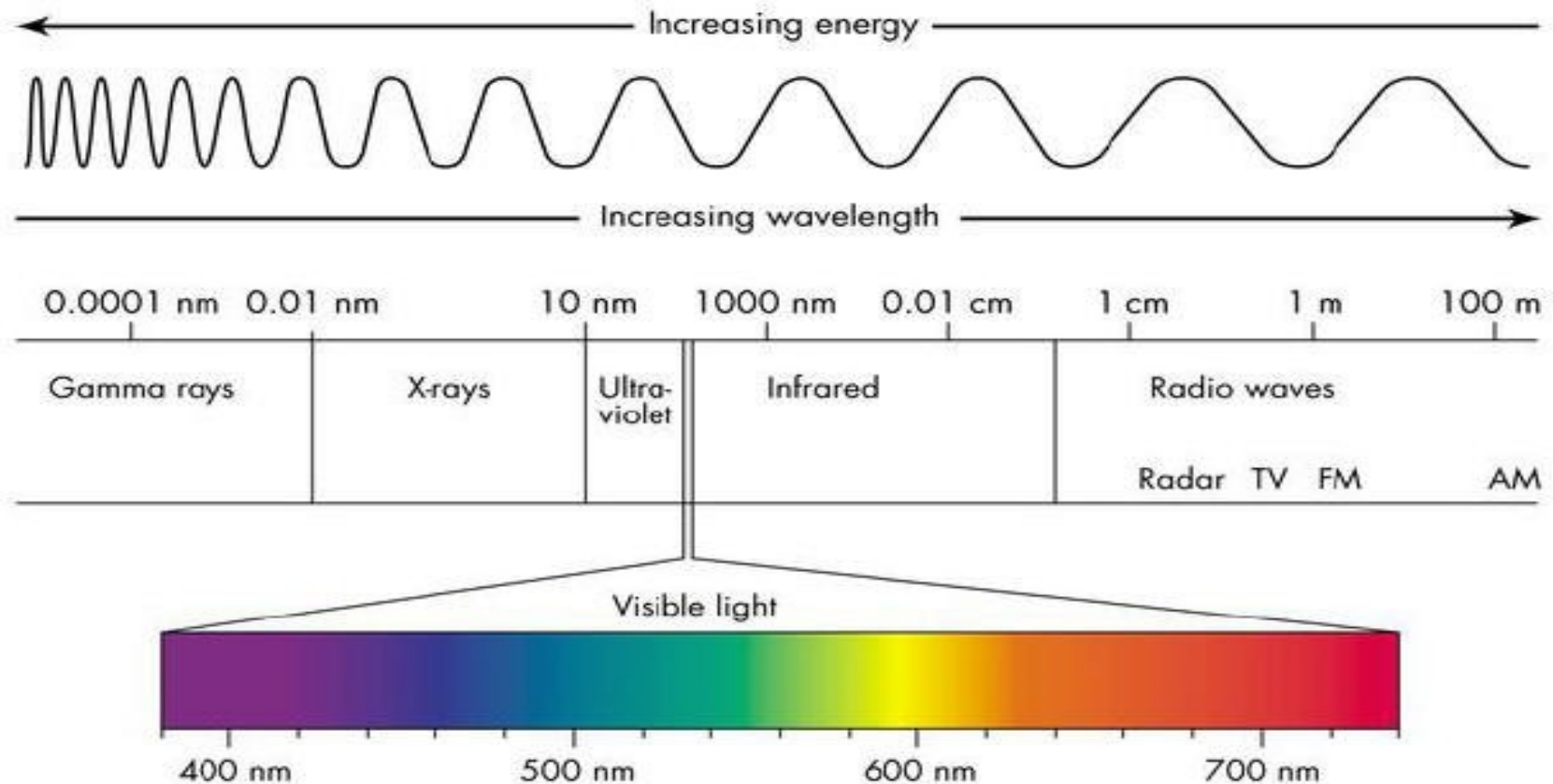


- A light curve represents a series of brightness measurements made over a period of time.



There's more!

- So far, we've only discussed optical telescopes
- There are many other types!

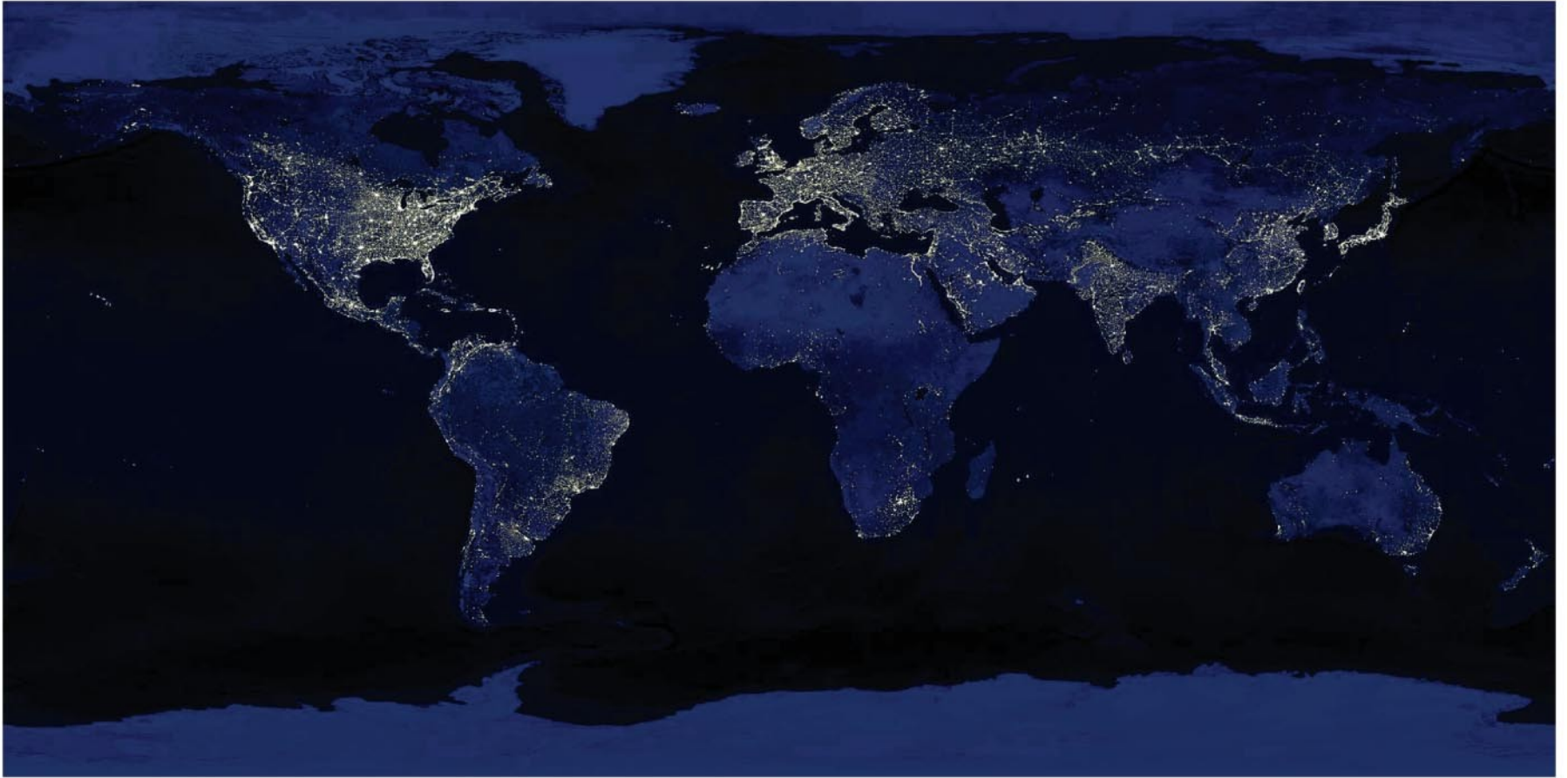


Ground or Space?

- There are two different classes of telescopes: ground based and space based
- Ground based telescopes are used on Earth, while space based ones go into outer space to observe
- Why do you think we would put telescopes in space? Why not just keep them on Earth?



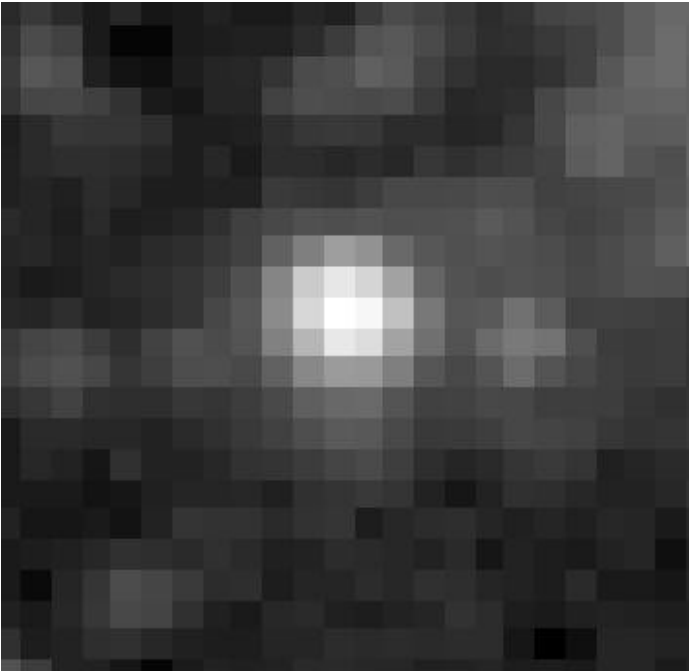
Light Pollution



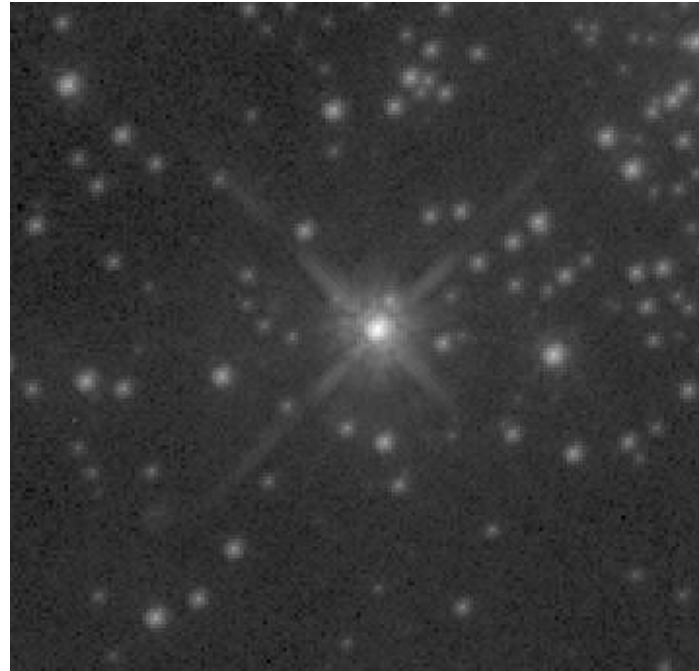
- Scattering of human-made light in the atmosphere is a growing problem for astronomy.



Twinkling and Turbulence



Bright star viewed with ground-based telescope

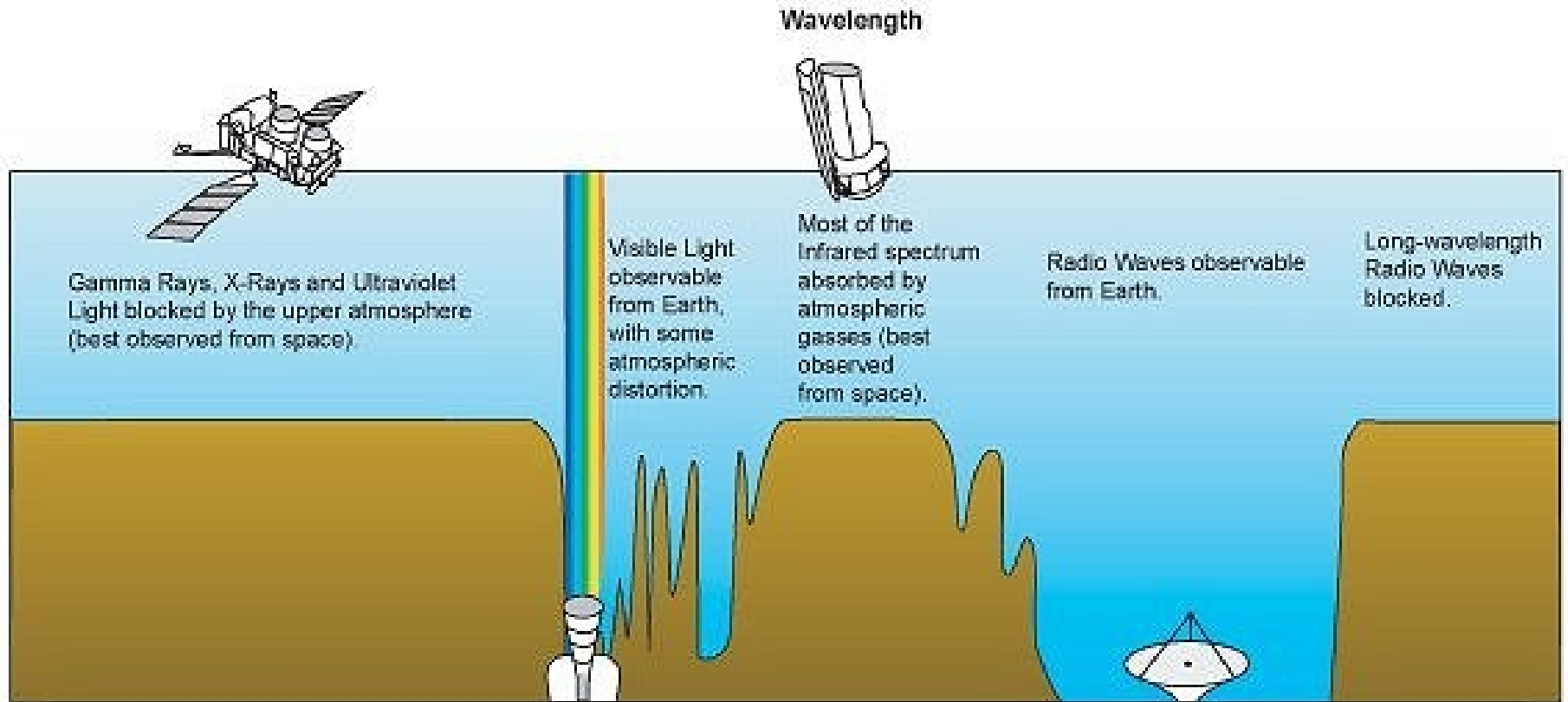


Same star viewed with Hubble Space Telescope

- Turbulent air flow in Earth's atmosphere distorts our view, causing stars to appear to twinkle



That Darn Atmosphere!



- The atmosphere blocks certain wavelengths of light

Ground: Visible telescopes



Kitt Peak, Arizona on
top of a mountain

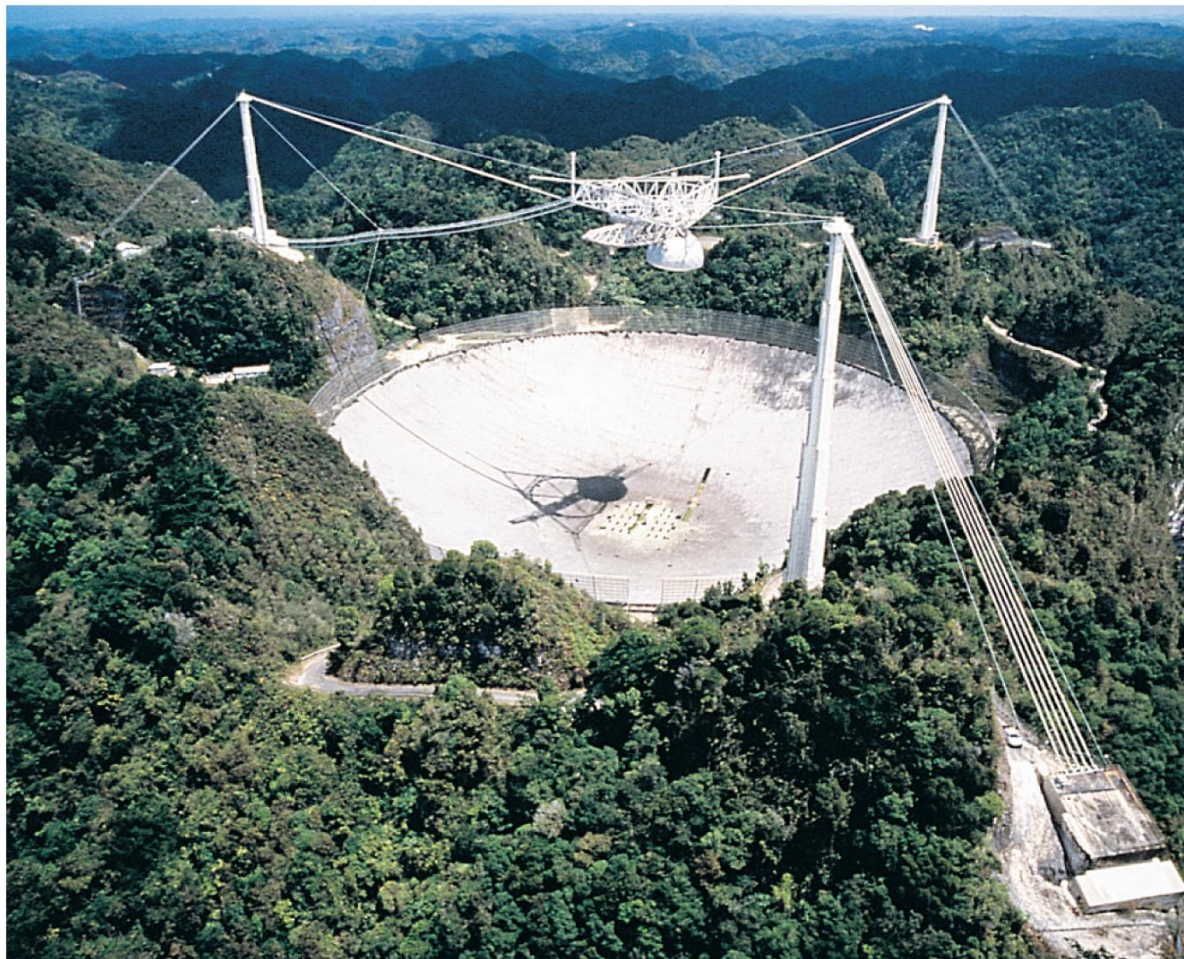


Mauna Kea, Hawaii
Over 80 telescopes
here!



Ground: Radio telescopes

- A radio telescope is like a giant mirror that reflects radio waves to a focus.



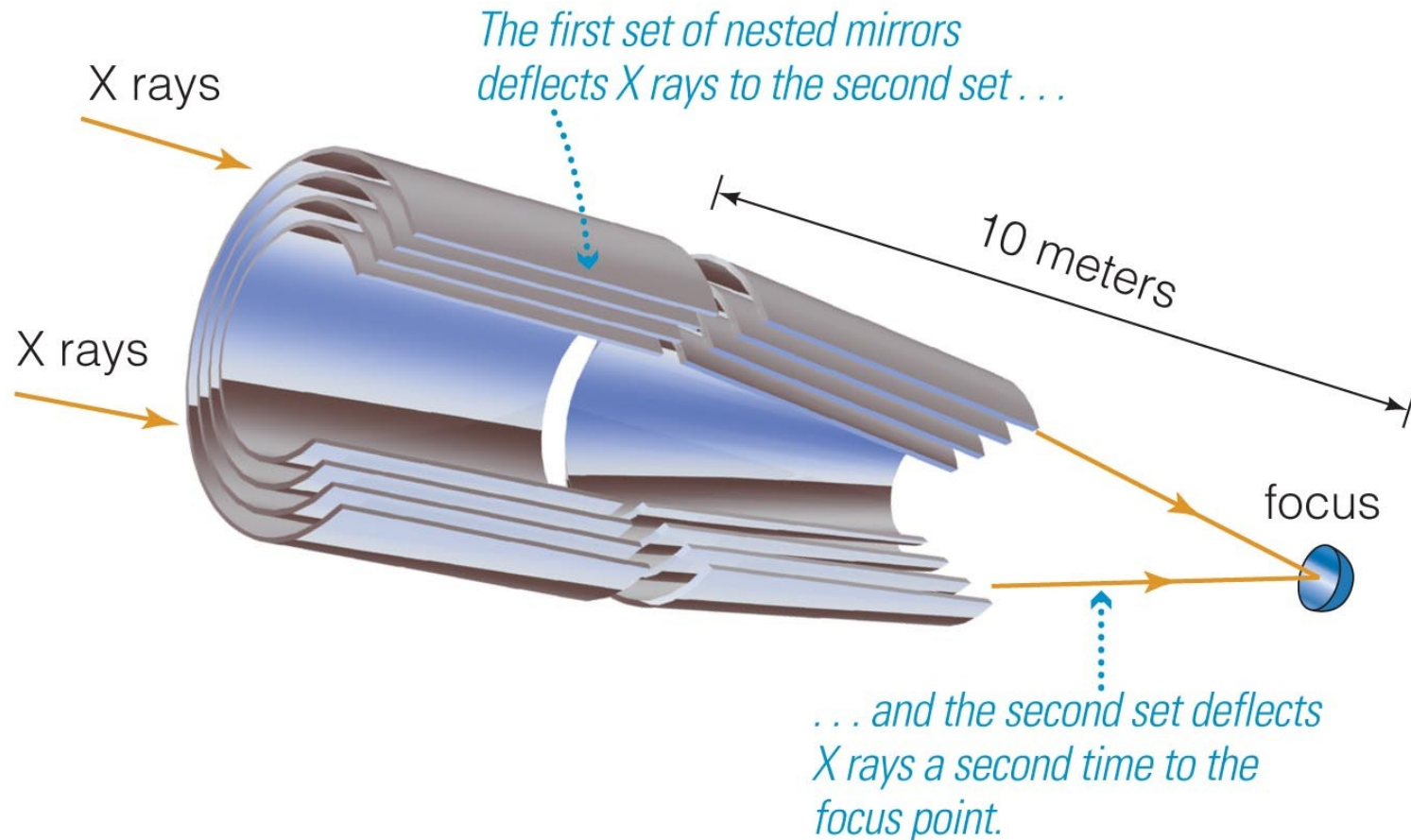
Space: X-ray telescopes

- X-ray telescopes must be in space because Earth's atmosphere absorbs x-rays



Chandra X-ray Observatory

X-Ray Telescope “mirrors”



- Focusing of X-rays requires special mirrors.
- Mirrors are arranged to focus X-ray photons through grazing bounces off the surface.



Space: UV telescopes

- Space based if you want to detect all UV wavelengths



Galaxy Evolution Explorer (GALEX)



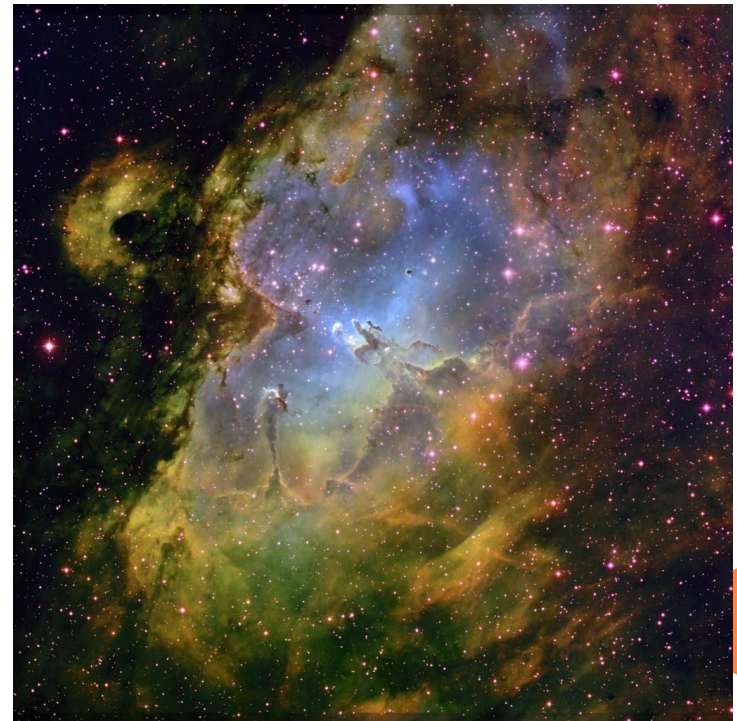
Andromeda

Space: Visible telescopes

- Visible light telescopes in space avoid problems from light pollution, atmosphere and weather



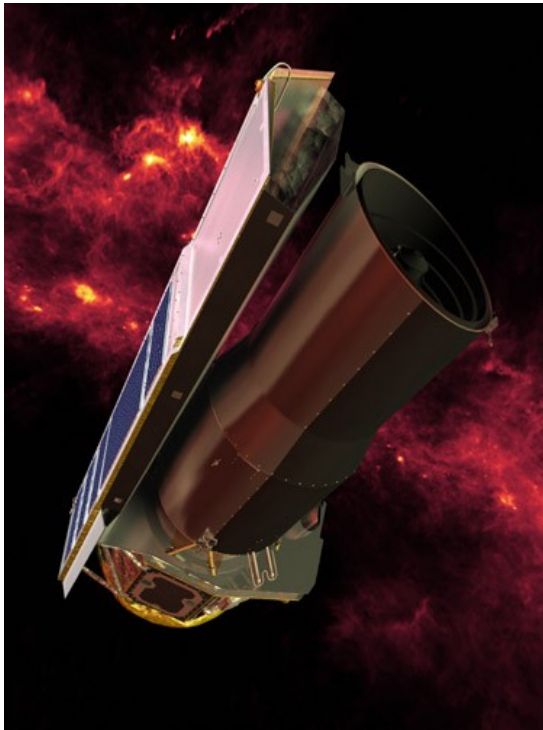
Hubble



Eagle Nebula

Space: Infrared telescopes

- IR is best observed from space
- Can also observe high in the atmosphere



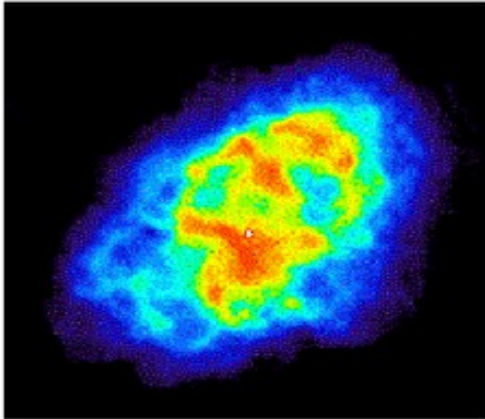
Spitzer



SOFIA

The importance of Astronomy in all wavelengths

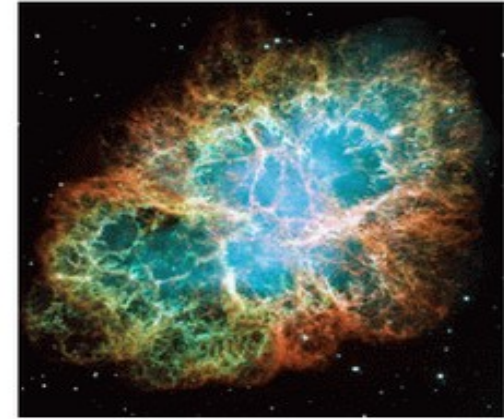
Crab Nebula: Remnant of an Exploded Star (Supernova)



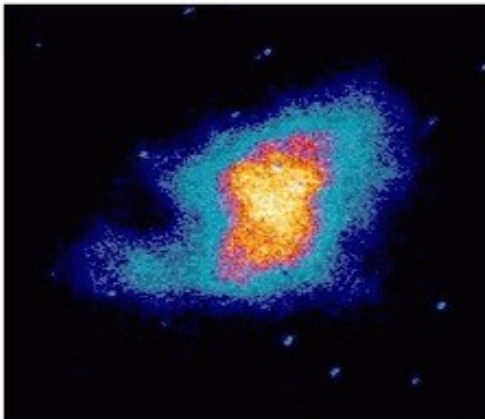
Radio wave (VLA)



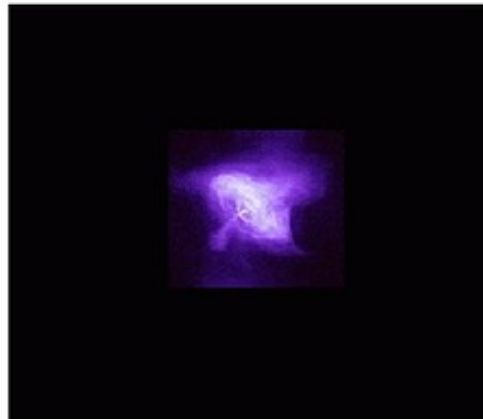
Infrared radiation (Spitzer)



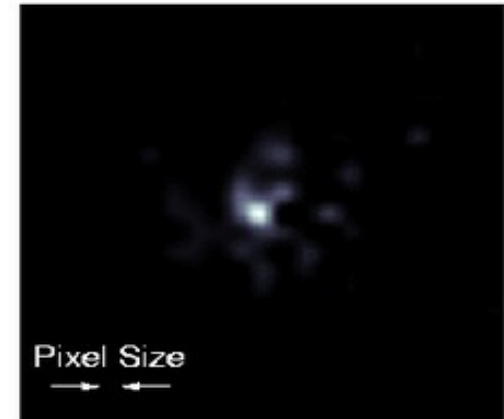
Visible light (Hubble)



Ultraviolet radiation (Astro-1)




Low-energy X-ray (Chandra)



High-energy X-ray (HEFT)
*** 15 min exposure ***

Things to consider

- When building a telescope you must consider:
 - 1) Atmosphere: will light make it through?
 - 2) Weather: is it cloudy or rainy often?
 - 3) Temperature: too cold/too hot?
 - 4) Location: dry desert? High atop a mountain?
 - 5) Cost: putting things in space is expensive! Do you absolutely have to?
 - 6) Accessibility: is it difficult to get to the location?
- 

What have we learned?

- **What are the two basic types of telescopes?**

- Refractors (lenses) and Refelctors (mirrors)

- **What do astronomers do with telescopes?**

- Imaging- take pictures
- Spectroscopy- break light into spectra
- Time monitoring- measuring light output with time

- **Space vs. ground- which is better and why?**

- Ground based telescope are hindered by the atmosphere, weather and light pollution
- Many wavelengths of light do not penetrate the atmosphere, so we must go to space!
- Space is expensive, but often necessary

Reading: Chapter 5.1-5.2



Lecture Tutorial

- Telescopes and Earth's Atmosphere: Pg 51-53

