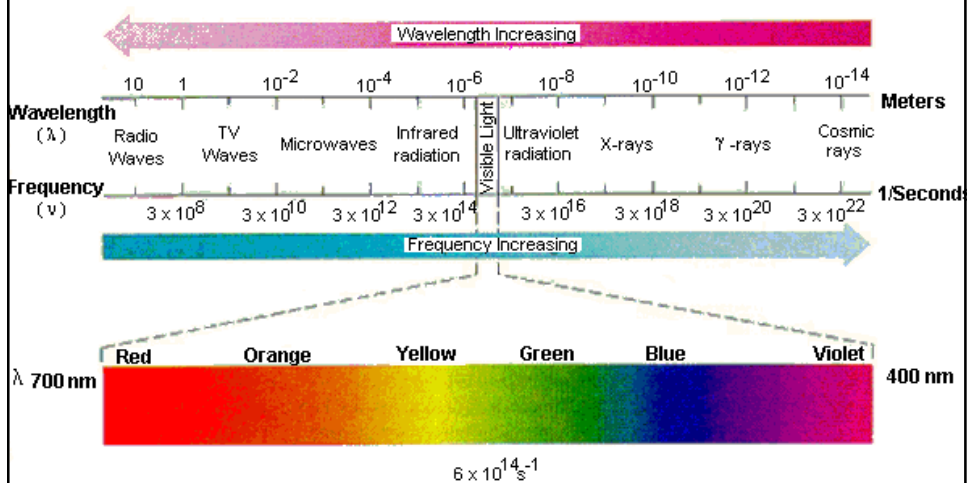


## Ch. 22 Exploring Space

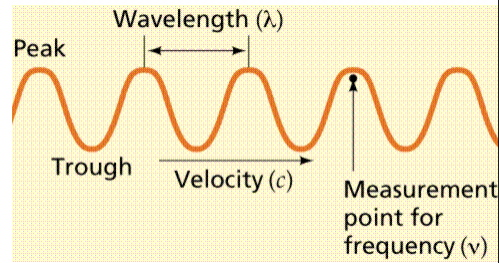


## Electromagnetic Waves

- Radiation--energy that's transmitted from one place to another by electromagnetic waves. These rays are carried through space & matter.



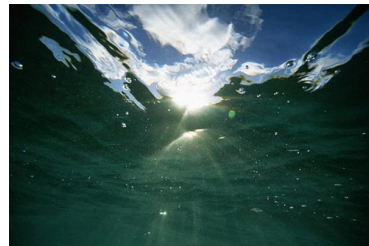
## Wavelength vs Frequency



- Wavelength—distance between crest to crest. Unit of measurement = meters.
- Frequency—number of wave crests that pass a given point per unit of time. Unit of measurement = Hertz
- The lower the wavelength, the higher the frequency.

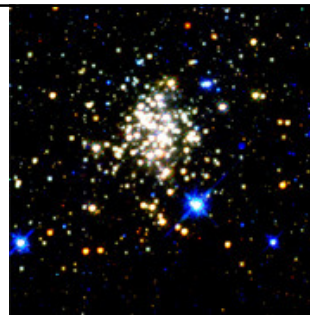
## How fast do they travel?

- They all travel at the speed of light.
  - 300,000 Km/s (in a vacuum)
  - Or 186,000 mi/s (in a vacuum)



## Starlight, Star Bright

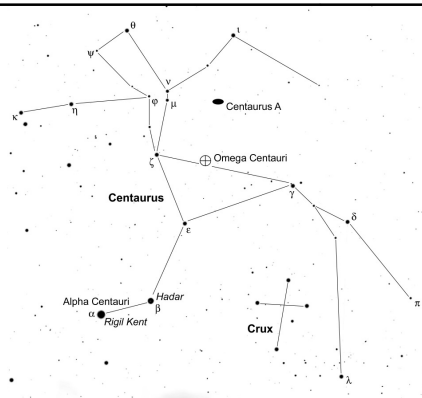
- Are all the stars you see really there?
  - NO!!!
  - The light from most stars you see was produced millions of years ago.
- How long does it take light from our nearest star to reach Earth?
- The Sun is 93,000,000 miles
- Light travels 186,000 mi/sec



$$\begin{aligned}
 & \cancel{93,000,000 \text{ miles}} \times \frac{1 \text{ sec}}{\cancel{186,000 \text{ mi}}} \\
 & = 500 \text{ sec} \\
 & = \cancel{500 \text{ sec}} \times \frac{1 \text{ min}}{\cancel{60 \text{ sec}}} \\
 & = 8.33 \text{ min} \quad \text{OR} \quad 8 \text{ min } 20 \text{ sec}
 \end{aligned}$$

## How about our next closest star?

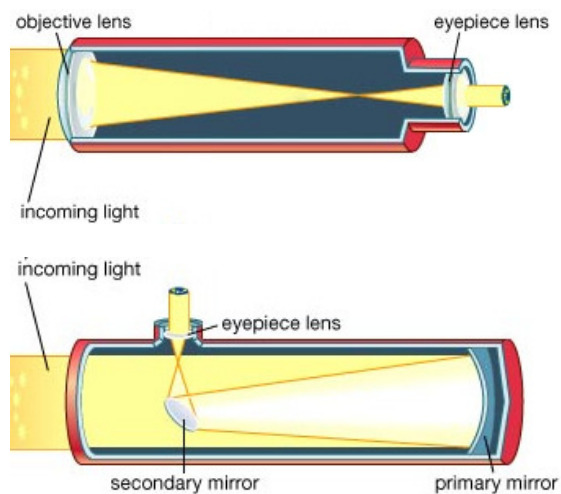
- Our next closest star is Proxima Centauri
- It is 4.22 light years from Earth
- What is a light year?
  - Distance light travels in one year.
  - Remember, light travels 300,000 km/s or 186,000 mi/s
  - A year is 60 sec x 60 min x 24 hrs x 365 days = 31,536,000 seconds
  - 31,536,000 seconds x 186,000 mi/sec ["Way to remember minutes in a year"](#)
  - That means a light year is  $5.85 \times 10^{12}$
  - OR 5,850,000,000,000 1 LIGHT YEAR = 5.85 Trillion Miles  
OR 9.4 Trillion Kilometers
  - Therefore, Proximal Centauri (4.22 ly away is 25 trillion miles or 40 trillion kilometers



## Telescopes

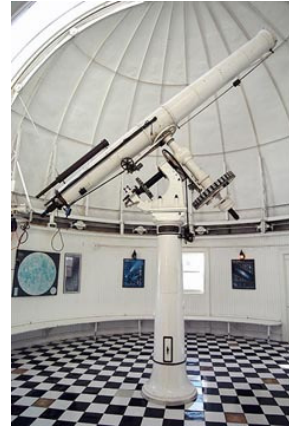
- We study light in space using telescopes.
- There are two main categories of telescopes.
- Optical Telescopes: use visible light
- Radio Telescopes: use radio waves
  
- There are now telescopes which use Gamma Rays, X-Rays, Ultraviolet, Infrared, & Microwaves.

## Refracting Optical vs. Reflecting Optical Telescope



## Using Optical Telescopes

- Observatories often have a dome shaped roof that opens and closing for viewing.



12 in USNO Refracting  
Telescope in Washington DC

## Are all Telescopes in Observatories?

- Some telescopes, such as Hubble are located in space.
- What is the advantage of being in space?
  - No light pollution or atmosphere to look through.



## Radio Telescopes



- Radio telescopes study radio waves traveling through space.
- Why don't these need to be in space?
  1. Radio waves travel freely through our atmosphere.
  2. These telescopes are often used to search for intelligent life.

## History of the Telescope

- 1608—Hans Lippershey, Dutch spectacle maker invented the telescope. Uses concave and convex lens and tube.
- 1609—Galileo Galilei, Italian mathematician/physicist turned the telescope on the sky to study planets and stars.
- 1611—Johannes Kepler, German mathematician. He made improvements to the telescope including the eyepiece.
- 1672—Sir Issac Newton invents the reflecting telescope. (Uses concave mirror)



## Worlds largest Telescopes



- Keck I and Keck II—twin reflecting telescopes. Largest in the US. (2<sup>nd</sup> largest in the world)
- Size: 10.0 m reflectors (Each)
- Location: Mauna Kea, Hawaii

## Gran Telescopio Canarias (GTC)

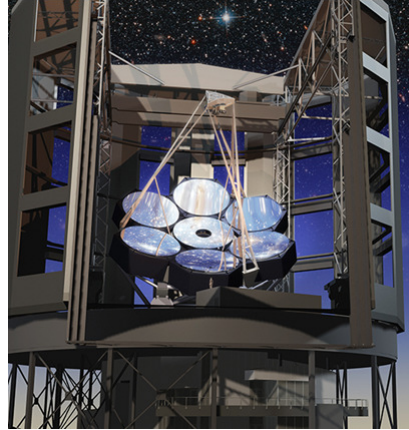
- World's largest reflecting telescope (As of 2009)
- 10.4 meter “mirrors”
- Location: Canary Islands





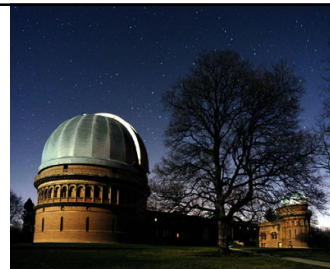
## Giant Magellan Telescope (GMT)

- To be completed in 2022 in Chile
- Segmented mirror telescope
- 7 mirrors creating a 80 feet diameter surface area.
- The GMT will have a resolving power 10 times greater than Hubble.
- <http://www.gmto.org/pbsspecialfeatur.html>



## Largest Refracting Telescope

- Yerkes Observatory Telescope (1897)
- 1 meter (40 inches)
- Williams Bay, Wisconsin (On Lake Geneva)
- Considered the birthplace of astrophysics.



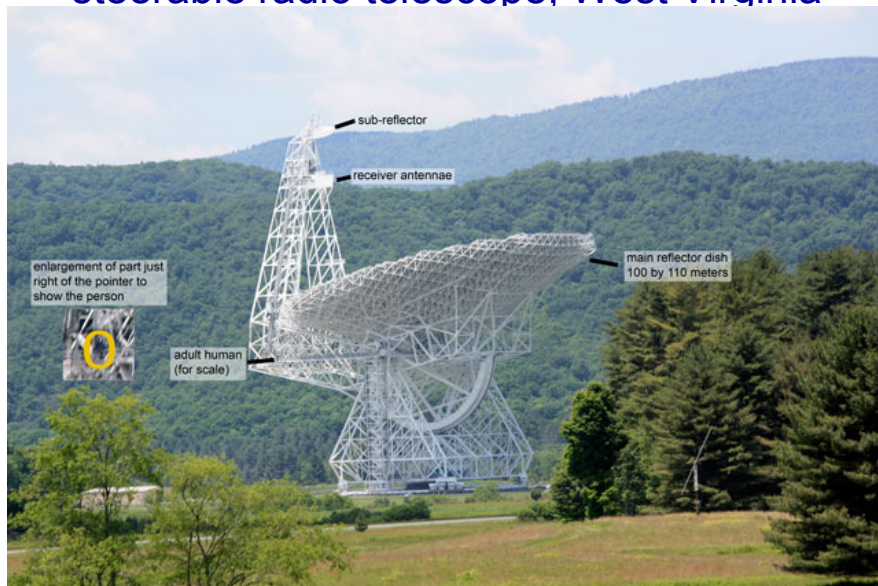


## The largest Radio Telescopes

- The largest radio telescope is the Arecibo Telescope (305 m or 1000 ft)
- Puerto Rico



## Robert C Byrd Telescope, largest fully steerable radio telescope; West Virginia



## Worlds Largest Orbiting Telescope

- Hubble Space Reflecting Telescope
  - 2.4 meter mirror
  - 1990—placed into orbit 270 miles above Earth.
  - Cost: 1.5 billion dollars

– [http://hubblesite.org/the\\_telescope/where.a.s.\\_hubble\\_now/](http://hubblesite.org/the_telescope/where.a.s._hubble_now/)



## Calculating Magnifying Power of a Telescope

- Magnifying Power = Objective (Telescope) Focal Length/Eyepiece focal length
- Both numbers should always be in millimeters
- REFRACTING TELESCOPE
  - Focal Length = 700 mm
  - Eyepiece Focal Length = 20 mm
  
  - Calculation
  - $700 \text{ mm} / 20 \text{ mm} = 35 \text{ x}$

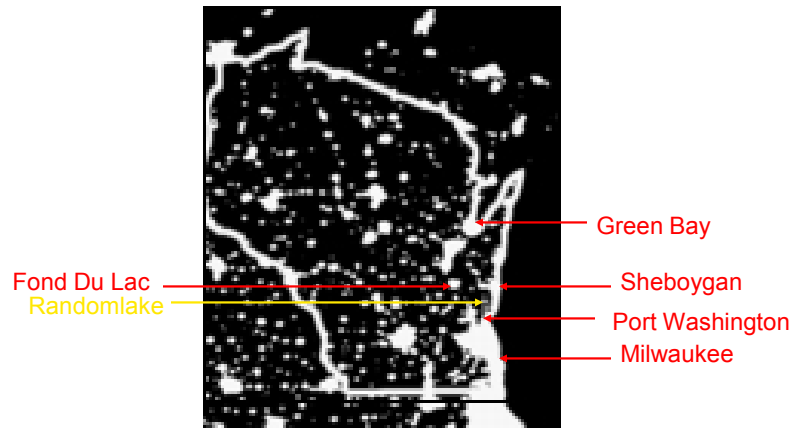
## More Practice Using Magnifying Power

### What is the largest obstacle for telescopes on Earth?

- Light Pollution
  - Glow in the sky caused by lights
  - Problem: dim stars are not visible
- What can we do?
  - Use low sodium lights (these can be filtered)
  - Hoods on billboards, parking-lot lights, floodlights

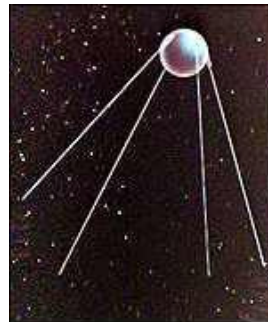


## Can you find us?



## First Steps Into Space

- 1957—Sputnik I
  - First artificial satellite, launched by rocket by the former Soviet Union.
  - *Sputnik* is Russian for “companion” or “friend”
  - It orbited the Earth for 57 days.
  - Where did Sputnik IV’s pieces land?

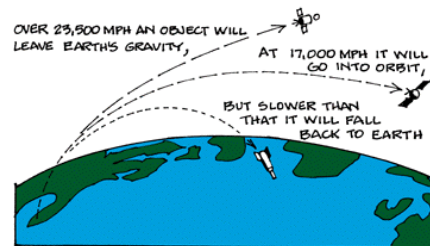
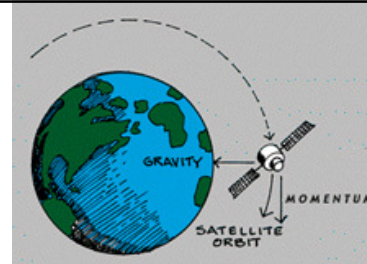


## How does a satellite stay in orbit?

1. Objects in space travel in a straight line (*Inertia or momentum*)
2. Earth's gravity pulls on a satellite (*It falls toward Earth*)

RESULT: curved path around Earth

[Family Guy Orbit](#)



## Some Very Large Satellites

- What is Earth's largest satellite?
- The Moon (It goes around the Earth)
- Orbit Time = 27.3 Days (Orbit if we are not moving)
- The Earth is also a satellite.
- Orbit Time = 365.25 Days
- What is the largest satellite in the solar system?
- The Sun (It goes around the center of the Galaxy)
- Orbit Time = 225 Million Years

## Space Probes

- An instrument that gathers information and sends it back to Earth.

## Race for Space

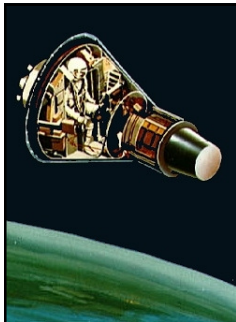
- First Man in Space
  - 1961--Yuri Gagarin (Soviet Cosmonaut)
  - 1st to orbit Earth & return safely.
- JFK--called for the US to place the first person on the moon.
- The "Race for Space".
- [Rockets to the Moon--Video \(2 Min\)](#)





## The Race for Space

- Three Parts
  - Project Mercury
  - Project Gemini
  - Project Apollo
- [Overview Pt 1](#)
- [Overview Pt 2](#)

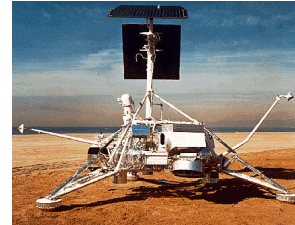


## Project Mercury

- **Goals: to orbit a piloted spacecraft around Earth and bring it safely back.**
- 1<sup>st</sup> US Citizen in Space (May 5, 1961)
  - Alan Shepard
- 1<sup>st</sup> US Citizen to orbit Earth (1962)
  - John Glenn

## Project Gemini

- Goals: Teams of 2 orbit Earth. One Gemini space craft met and connected with another Gemini space craft



## Project Apollo

- Goal: To reach the moon and return
- July 20, 1969
- Apollo 11 (3 Astronauts)
- landed on the lunar surface
- Neil Armstrong--1st human on the moon
- "That's one small step for man, one giant leap for mankind."
- Michael Collins
  - Commander, remained in the *Command Module* orbiting the moon
- Edwin (Buzz) Aldrin
  - 2nd human on the moon
- 6 lunar landings (1969-1972)



Buzz Aldrin exiting Apollo 11 lunar module  
Image courtesy NASA

## The Space Shuttle

- Reusable spacecraft used from 1981-2011 To transport astronauts, satellites, & other materials to and from space.



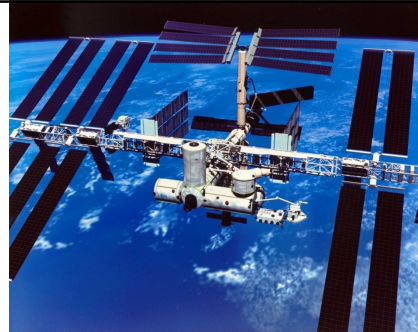
## Space Stations-- Skylab

- Skylab
  - Has a large living quarter for work & exercise.
  - US Space Station ('73-79)
- Mir
  - Former Soviet Union
    - Record stay: 438 Days
    - 1986-2001



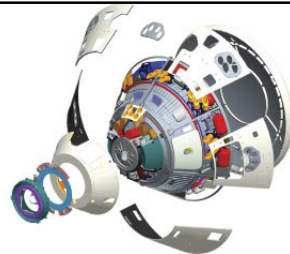
## International Space Station

- 1997
  - Used as a docking site for ships and, repair station.
  - Completed 2011



## Return to the Moon

- [http://www.nasa.gov/mission\\_pages/constellation/main/cev.html](http://www.nasa.gov/mission_pages/constellation/main/cev.html)
- By 2017 the Orion capsule will be launched by the Aries V and we will begin trips to the ISS.
- 2020—to return to the Moon
- Orion will be launched with the Aries Launch Vehicle.
- This capsule is much larger than Apollo, large enough for 10 crew members.



## Exploring Mars

- 2003 (arrived '04)
  - Twin Rovers were launched
  - Opportunity & Spirit
  - So, what does it cost?
    - \$20,000,000/year
  - Dec 2011—Opportunity reached the 21 mile mark, 32 times farther than the goal.

## Space Spin Offs

- It's all around us.
- Many take it for granted.
  
- Examples:
  - GPS
  - Computers
  - Contacts
  - The list goes on.

## The Beginning of the End

- 2011, ISS was completed. It can now house a 6 person permanent crew.
- After completion, the space shuttle was retired.
- In 2016, NASA funding for the ISS will end.
- Funds would be re-directed to returning to the Moon.

## Orion Spacecraft

- 2014—the Orion Spacecraft will be introduced





### Catastrophes

- 25 Astronauts have died
  - 17 Lost in space related accidents
  - 8 in aircraft accidents
- 8 Cosmonauts have died
- [Apollo 1](#)
  - 1967
  - 3 Killed
- [Challenger](#)
  - 1986
  - 7 Killed
- [Columbia](#)
  - 2003
  - 7 Killed

### What countries have/had space programs?

- United States
  - Astronauts
- Russia (Former Soviet Union)
  - Cosmonauts
- China
  - Taikonauts