Minor Members of the Solar System
Light
Astronomical Tools

Chapter 22, pages 629-635
Chapter 23, pages 640-649

Minor Members of Solar System

- Asteroids
- Meteoroids
- Comets
- Kuiper Belt Objects
- Dwarf Planets

"Planet"

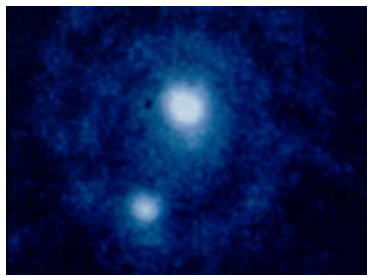
- Orbits Sun
- Not a satellite
- Dominates its orbital path

"Dwarf Planet"

- is in orbit around Sun
- has sufficient mass for its self-gravity to pull itself into near-spherical shape
- has not cleared the neighbourhood around its orbit
- is not a satellite

Pluto and Charon

HST image



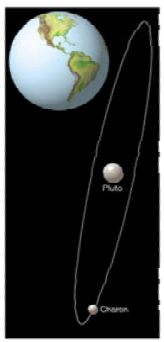
- http://www.solarviews.com/cap/pluto/pluto3.htm

Kuiper Belt

- Donut shaped area containing numerous icy bodies of various sizes
- Eris is the largest discovered
- Pluto and Charon are some
- Triton, moon of Saturn, is likely one that was captured by Saturn's gravity
- Origin of numerous comets that orbit Sun in periods less than 200 years

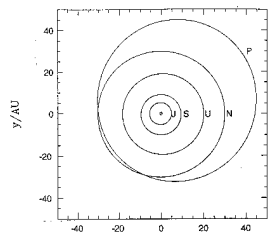
Pluto and Charon

- Pluto has Charon as a satellite, or they are twin dwarf planets
- Does not dominate its orbit
- Largest Kuiper Belt Object
  - "Plutonian objects" of which it is the original example



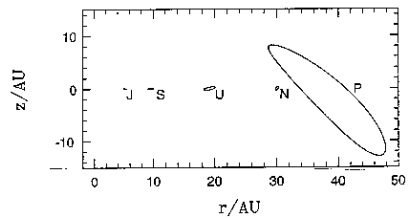
Orbits of outer planets

- Notice Pluto is sometimes closer to Sun than Neptune



- http://www.nineplanets.org/plutodyn.html

Inclination of Pluto's orbit



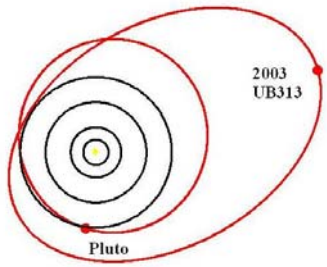
- http://www.nineplanets.org/plutodyn.html

Eris

- Kuiper Belt Object
- Larger than Pluto
- Discovered in 2003

http://en.wikipedia.org/wiki/Eris_(dwarf_planet)

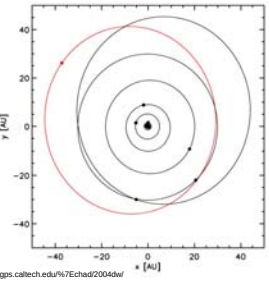
Eris (2003 UB 313)



http://www.gps.caltech.edu/~mbrown/planetlila/#size

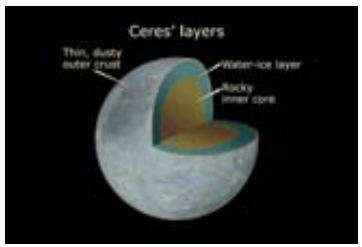
Orbit of 2004 DW Kuiper Belt Object

In red
Compare to Pluto in black



- http://www.gps.caltech.edu/%7Echad/2004dw/

Ceres composition



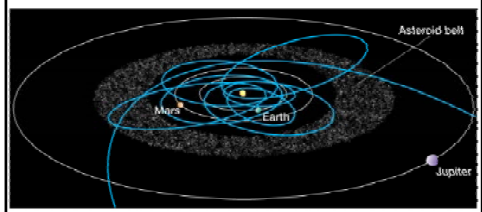
- http://www.space.com/scienceastronomy/050907_ceres_planet.html

Asteroids

Ida,
Gaspra,
Deimos,
Phobos

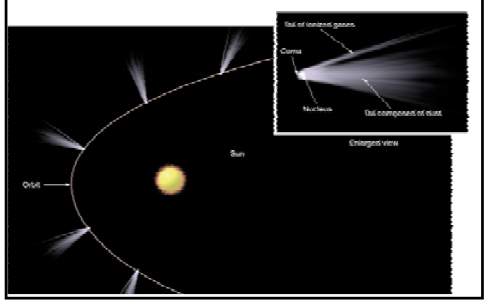
- http://www.nineplanets.org/asteroids.html

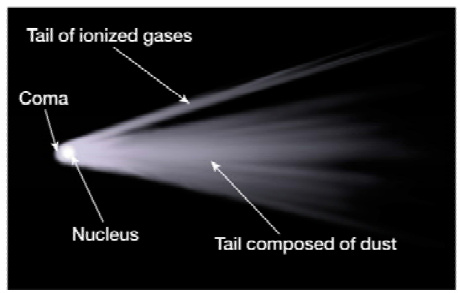
Asteroids

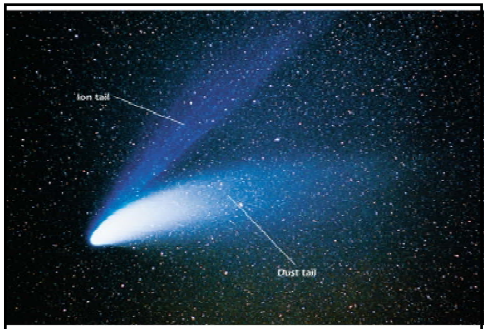


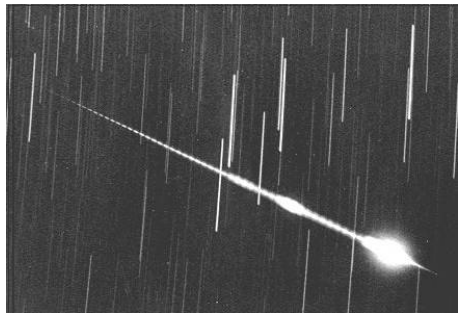
Gaspra

Comet



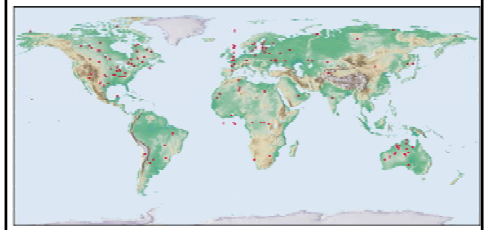






- http://www.dmsweb.org/

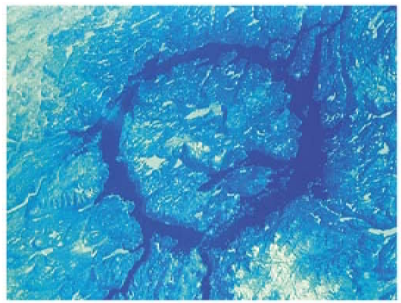
Major Impact Structures



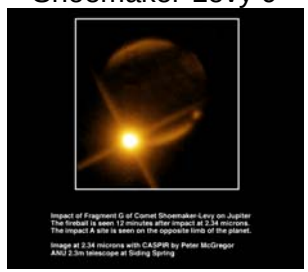
Meteor Crater, Arizona

- http://www.xtec.es/recursos/astronom/craters/METEOR.jpg

Manicouagan, Quebec



Shoemaker-Levy 9



- http://www.nineplanets.org/sl9.html

- http://nssdc.gsfc.nasa.gov/planetary/sl9/image/sl9g_hst5.gif

The Nature of Light

- Light is made of photons
- Photons act as particles
- Photons act as waves

Waves

- Movement of energy, not of matter

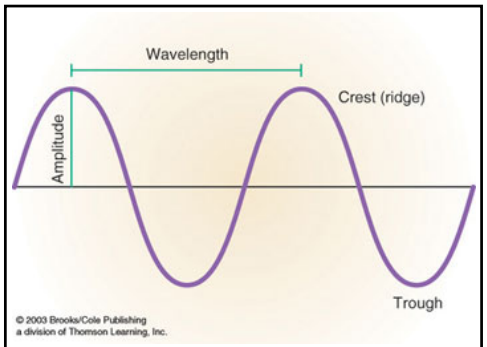
Overlapping ripples

Waves are movement of energy

- The matter pretty much stays put
- Video link below, clip #142-69

http://www.4oliveus.com/land_4_sale/images/L_Wave_of_Grass.jpg

http://creative.gettyimages.com/source/frontdoor/DefaultFilm.aspx



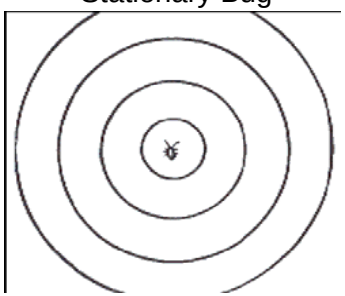
http://cimss.ssec.wisc.edu/satmet/modules/spectrum/wavelength.html

Wave Description

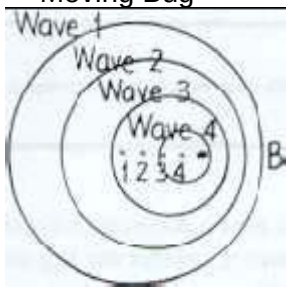
- Wavelength—distance from one part of the wave to the same part of the next wave
- Crest—top
- Trough—bottom
- Amplitude—distance from midway between crest and trough, to the crest or trough
- Period—time for one complete wave to pass
- Frequency—how often the wave passes

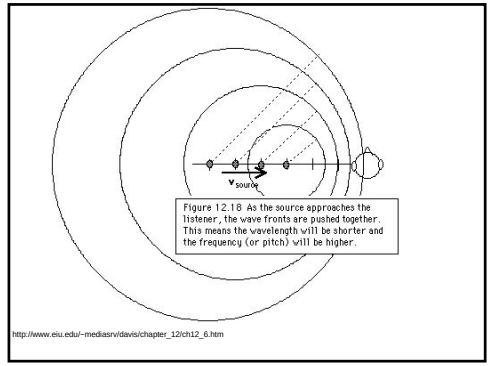
http://www.yenra.com/banner-ad-effectiveness/

Stationary Bug



Moving Bug

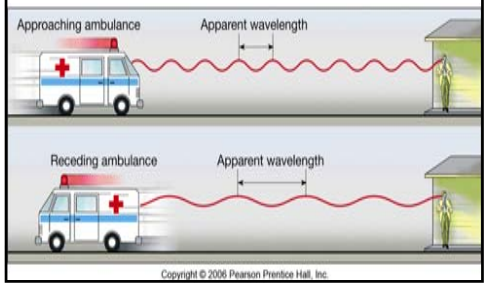




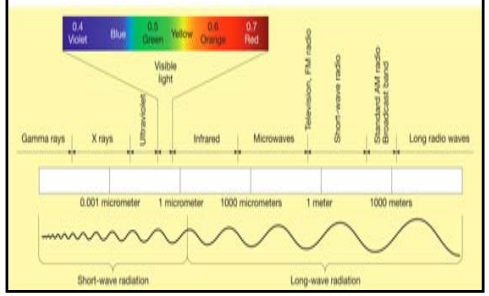
http://www.eiu.edu/~mediasrv/davis/chapter_12/ch12_6.htm

Doppler Effect of Siren

Doppler effect of movement on the reception of wave forms



Electromagnetic Spectrum



Spectrum

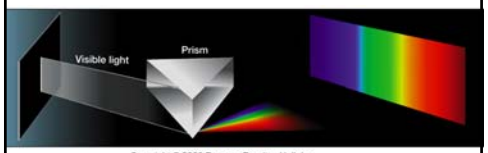


TABLE 23.1 Colors and corresponding wavelengths.

Color	Wavelength (nanometers*)
Violet	380–440
Blue	440–500
Green	500–560
Yellow	560–590
Orange	590–640
Red	640–750

*One nanometer is 10^{-9} meter.

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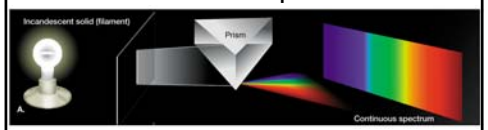
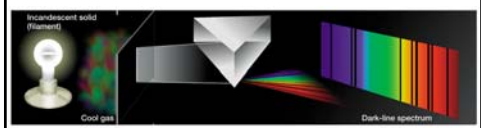
Continuous Spectrum



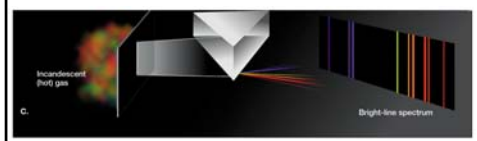
- From glowing gas under pressure
- Like the interior of Sun

Dark Line Spectrum

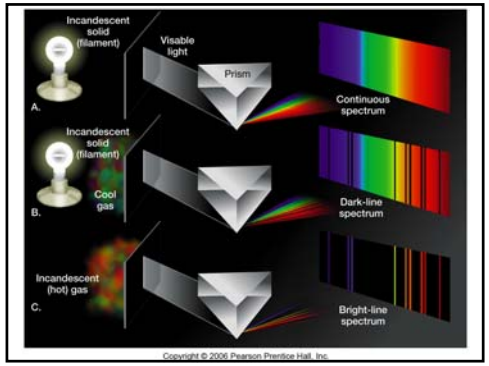


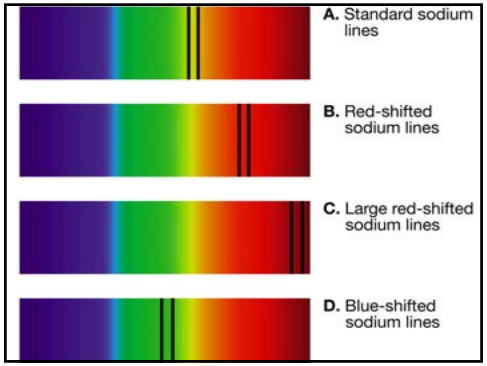
- White light passing through cold, low pressure gas
- Gas absorbs its elemental wavelength signature

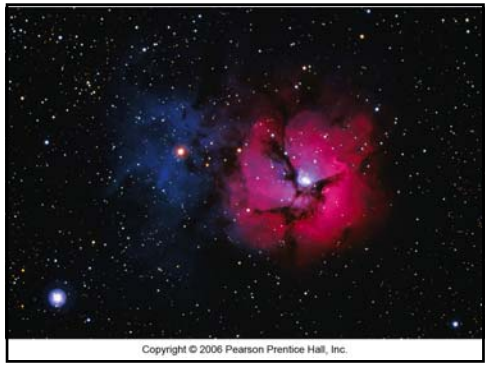
Bright Line Spectrum



- Incandescent hot gas emits its elemental wavelength signature



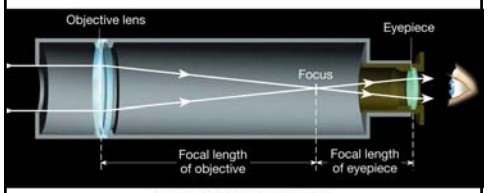




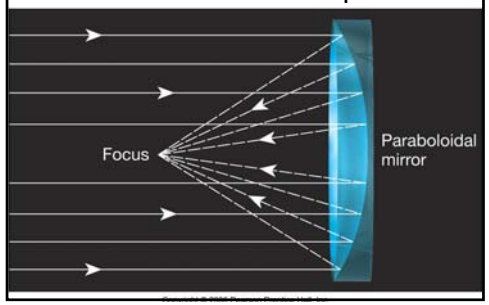
Astronomical Tools

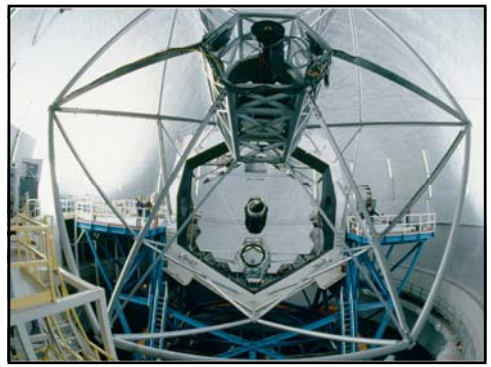
- Optical Telescopes
  - Refracting telescope
  - Reflecting telescope
  - Space telescopes
- Other telescopes
  - Radio telescopes
  - Infra-red sensing
  - X-ray, gamma ray emissions

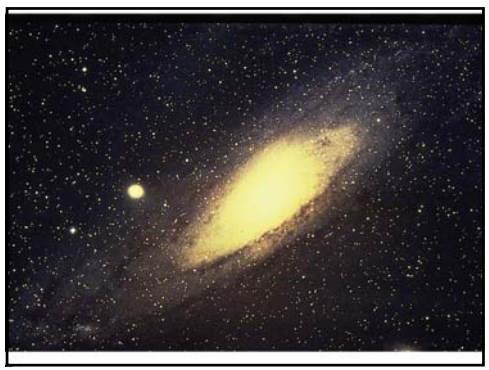
Refracting Telescope



Reflector Telescope

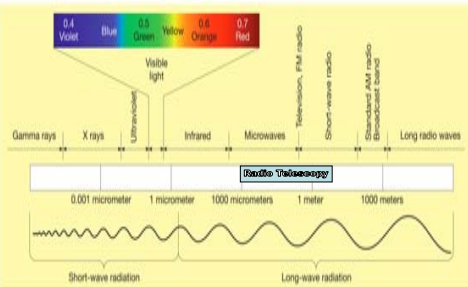






Hubble Space Telescope

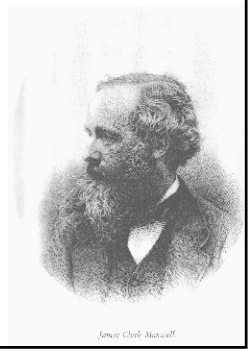
Electromagnetic Spectrum



James Maxwell

Unified electricity and magnetism into aspects of the same force

1860-1870



http://www.nrao.edu/whatisra/hist_prehist.shtml

Heinrich Hertz

Built device to transmit 5 m long electromagnetic waves

1888

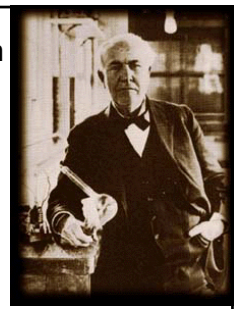
http://www.nrao.edu/whatisra/hist_prehist.shtml

Thomas Edison

Proposed experiment to measure electromagnetic radiation from Sun

1890

Never conducted the experiment



http://www.nrao.edu/whatisra/hist_prehist.shtml

Guglielmo Marconi

Sensitive radio receiver allowed communication

http://www.nrao.edu/whatisra/hist_prehist.shtml#marconi

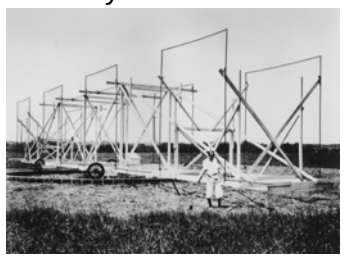
Karl Jansky's radio discovery

Found radio emission from Milky Way

1933

http://www.nrao.edu/whatisra/hist_jansky.shtml

Jansky's radio antenna



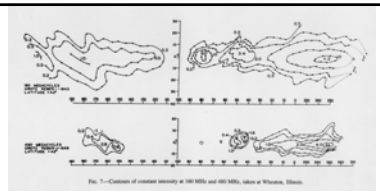
http://www.nrao.edu/whatisra/hist_jansky.shtml

Grote Reber

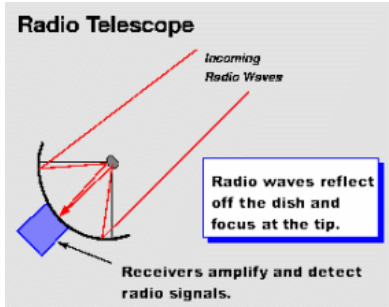
http://www.nrao.edu/whatisra/hist_reber.shtml

Reber's dish antenna

http://www.nrao.edu/whatisra/hist_reber.shtml

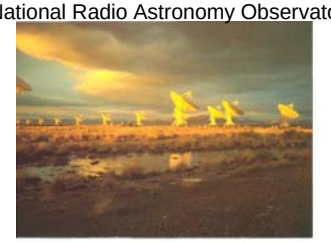


Reber's galactic map of radio emissions



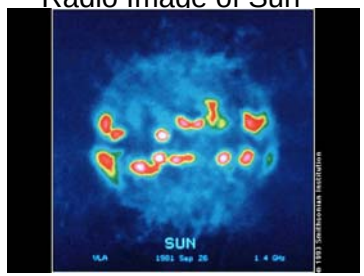
http://www.nrao.edu/whatisra/radiotel.shtml

National Radio Astronomy Observatory



Plains of San Agustin, New Mexico, USA
Very Large Array in golden glow at dusk
Photo by Kelly D. Gatlin

Radio Image of Sun



http://seds.lpl.arizona.edu/nineplanets/nineplanets/pxsol.html