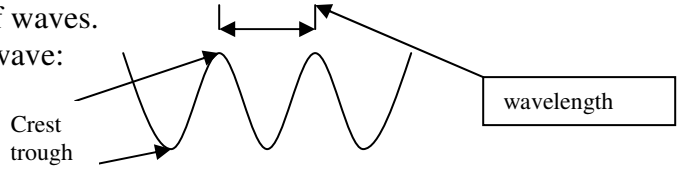
Physical Science
Lecture Notes
Chapter 24, 23 & 22

I. Chapter 24: Stars, Galaxies and the Universe
A. Tools of Modern Astronomy
1. **E**lectro**M**agnetic **R**adiation
a. **Electromagnetic Radiation** is energy that can travel directly through space in the form of waves.
b. Parts of a wave:



c. EMR spectrum includes (in order from longest wavelength to shortest wavelength) radio waves, infared, visible light, ultraviolet, X-rays and gamma rays.
d. Visible light waves in order from longest wavelength to shortest wavelength: Red, Orange, Yellow, Green, Blue and Violet
2. Telescopes: collect and focus EMR
a. Visible Light Telescopes
i. Refracting Telescope: collects and focuses light using convex lenses
ii. Reflecting Telescope: uses a curved mirror to bounce the light onto a small area
b. Radio Telescope: Uses a large parabolic dish to collect and focus radio waves
3. **Spectrographs**: break light into its visible components
a. Astronomers use spectrograths to determine temperatures and chemical composition of the stars they are looking at.
B. Characteristics of Stars
1. **Constellation**: a group or pattern of stars in the night sky that appeared as symbols or figures to ancient star gazers
a. Big Dipper, Orion, Gemini, Little Dipper, etc.
2. Distance units
a. **AU** – astronomical unit – distance from the Earth to our Sun, about 93 million miles or 150 million kilometers
b. **Light Year**- distance light would travel in one year- a distance measurement, not a time measurement!!- 9.5 million million kilometers!
3. Classifying stars: three characteristics used to classify stars: size, temperature and brightness
a. Size:
i. **Neutron star** – about 20 kilometers in diameter
ii. **White dwarf**- about the diameter of the Earth
iii. **Medium Size**- about the size of our sun
iv. **Red Giant**- several times the diameter of our Sun
v. **Super Red Giant** – can be the diameter of our entire solar syatem
b. Surface Temperature: revealed by the star's color
i. Red - about 3,000 degrees Centigrade
ii. Yellow- about 6,000 degrees Centigrade
iii. White – about 10,000 degrees Centigrade

iv. Blue – about 50,000 degrees Centigrade

c. **Brightness**: the amount of light given off by the star
   i. **Apparent Magnitude** – the brightness as seen from the Earth. As the distance from the star increases, the apparent magnitude of that star would decrease.
   ii. **Absolute Magnitude** – the brightness the star would have if it were a standard distance from the Earth.

4. **Hertzsprung – Russell Diagram**: a chart that compares Color, Surface Temperature and brightness of stars.
   a. **Main Sequence** – that group of stars that increase in brightness as their surface temperatures increase.

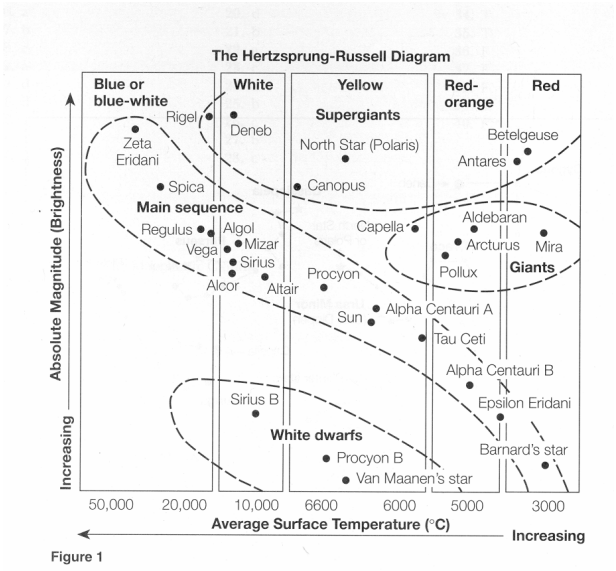
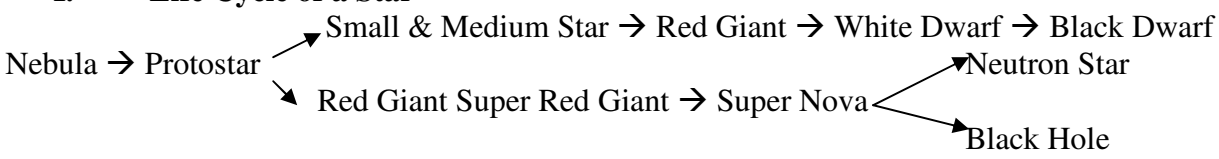


Figure 1

C. Lives of Stars
1. Birth of a Star:
   a. **Nebula** – a huge gas cloud made up mainly of Hydrogen that collapse down on itself and compresses the gas down into a **Protostar**
   b. Star is "born" when the protostar has contracting tight enough for Hydrogen to fuse into Helium, this releases the light and energy we normally associate with a "normal" star.
2. Life of a Star
   a. How long a star lives depends on its initial mass – the more mass stars use their fuel faster than less massive stars!
      i. Stars smaller than the Sun have lives up to 200 billion years
      ii. Medium Stars, like our Sun – have lives about 10 billion years
      iii. Massive Stars – have very "short" life spans – about 10 million years
3. Death of Stars
   a. As the fuel burns out, all stars will become Red Giants or Super Red Giants
   b. After the Red Giant stage a star will become a white dwarf, neutron star or a black hole.

I. Life Cycle of a Star



D. History of the Universe
   1. Galaxy – is a group of 100's of Billions of stars
      a. Three main shapes
         i. Spiral, Elliptical and irregular
      b. 100's of billions of galaxies make up the known universe
   2. **Big Bang Theory**
      a. The Big Bang Theory says that the entire universe began 15 to 20 billion years ago.
      b. Scientist have viewed thousands of galaxies and can measure the fact that all galaxies are moving away from each other.
      c. If you could run the film "backwards", it would appear that all of the galaxies come together at a single incredibly dense point.
      d. Scientist CANNOT Explain where this dense point came from!! WE CAN:
         i. **Gen 1:1** – In the beginning, God created the Heavens and the Earth

II. Chapter 23: The Solar System

A. Observing the Solar System
   1. Greeks watched the stars move across the sky and noticed five "stars" that wandered around and did not follow the paths of the normal stars. They called them Wander Stars "planets".
   2. "**Wandering Stars**" were: Mercury, Venus, Mars, Jupiter and Saturn
   3. Greek Astronomer **Ptolemy** believed: *Geocentric* - Earth centered Solar system
   4. **Copernicus**: Polish Astronomer believed: Heliocentric – Sun centered Solar System
   5. **Galileo:** confirms Copernicus belief
      a. He used telescope to see 4 moons revolving around Jupiter and that Venus went through phases just like our moon
         i. These things couldn't happen if we were Geocentric, only if we were heliocentric
   6. **Brahe**, an astronomer, made very precise measurements of the location of the planets for over twenty years.
   7. **Kepler**, a mathematician, used Brahe numbers and determined that the orbits of the planets were elliptical not perfect circles.
   8. **Newton** – determines that planets stay in orbit because of Inertia and Gravity
      a. **Inertia** – an object at rest stays at rest, an object in motion stays in a straight line motion, until acted on by an outside force.
      b. **Gravity** – the attraction of two objects. The strength of gravity depends on the masses each object possess.

B. The Sun
   1. The Sun's Interior
      a. **Core** – Fusion takes place here, reaches temps of 15,000,000 degrees Centigrade. Most of the mass of the sun is found here.
      b. **Radiation Zone** – energy transferred from core out of the interior of the sun, reaches temperatures of 100,000 degrees Centigrade

c. **Convection Zone** – Convection Currents boil as the energy from the interior is transferred to the surface of the sun. temperatures drop to 6,000 degrees Centigrade

2. The Sun's Atmosphere

a. **Photosphere** - the surface of the sun, also known as the first atmospheric layer. It is what we see when we look at the sun
b. **Chromosphere** – the middle layer of the sun atmosphere, seen as a reddish glow at the beginning and end of a solar eclipse
c. **Corona** – the "white halo" is the outer layer of the sun's atmosphere, seen during total eclipses or w/ special filters on telescopes.
d. See "Need to Know Handout for additional info!!– high energy streams of electrically charged particles "blown" away from the sun in all directions
    i. Can cause problems with earth satellites, communications etc.
    ii. Produce the **Aurora borealis** – Northern lights
    iii. Produce the **Aurora australis** – Southern Lights

3. Features of the Sun
    a. **Sunspots**: areas on the sun surface that are cooler gases and cause dark spots, usually found in pairs,
        i. Dark inner portion of sunspot is the **umbra**, lighter colored outer portion of the sun spot is the **penumbra**
        ii. The number of sunspots found on the surface of the sun run in 11 year cycles.
    b. **Prominence**: a massive loop of plasma lifting off the surface of the sun
    c. **Solar Flare**: extremely strong prominences where the loop breaks away from one of its arms and "sprays" into space.

C. **The Inner Planets**: See "Need to Know Handout for additional info!!
    1. **Mercury, Venus, Earth, Mars, Asteroid Belt**

D. **The Outer Planets**: See "Need to Know Handout for additional info!!
    1. Jupiter, Saturn, Uranus, Neptune and Pluto

E. Comets, Asteroids and Meteors
    1. **Comets**
        a. Chunks of ice and dust that orbit the sun in extremely long narrow orbits
        b. Parts include Nucleus, Coma and the tail
    2. **Asteroids** see handout
    3. **Meteors**
        a. **Meteoroid**: rock/ice in space, usually from comets or asteroids
        b. **Meteor**: rock/ice that enters Earth's atmosphere, producing "shooting stars"
        c. **Meteorite**: rock that makes it through the atmosphere and lands onto the Earth's surface.

Chapter 22

I. The Space Race
    a. After WWII the US and the USSR (Soviet Union), were in a "**Cold War**". Each trying to reach space and take command of the "high ground".
    b. Soviets were way ahead in the beginning.
        i. First to orbit artificial satellite, **Sputnik I**
        ii. First to put a man in space and first to orbit the earth, **Yuri Grigaran**
        iii. First to place a female into space
    c. US played "catch up"

i. **John F. Kennedy** speech promises before the decade of the 60's is out, to land an American on the moon and return him safely to the Earth
ii. **NASA : National Aeronautics and Space Administration**
iii. 1st American in space, **Alan Shepard** w/ 15 minute suborbital flight
iv. 2nd American in space, **Gus Grissom**, also in a suborbital flight, blew the hatch on the capsule after splashdown and the capsule was lost. Because of this "accidental" blowing of the hatch a new, redesigned hatch is partially responsible for the Apollo 1 disaster.
v. 3rd American in space, **John Glenn**, first American to orbit the Earth later becomes US Senator from Ohio.

d. US manned space programs

Program	# of Astronauts	Purpose
Mercury	One astronaut	To see if we could survive or live in space
Gemini	Two astronauts	To see if we could work and Rendezvous
Apollo	Three Astronauts	Land safely and explore the moon
Shuttle	5 – 7 astronauts	Cargo ship to transport into low Earth orbit
International Space Station	Varies	Permanent Manned presence in space

i. 7 Original Mercury Astronauts: **Alan Shepard, Gus Grissom, John Glenn, Wally Schirra, Scott Carpenter, Gordon Cooper and Deke Slaton**
ii. Gemini proves rendezvous possible and first American Space walk
iii. Apollo Program
    1. **Apollo 1** Disaster: **Ed White, Roger Chaffe and Gus Grissom** die in launch pad fire while inside their Apollo 1 capsule. Fire was a result of 100% pure oxygen inside capsule, redesigned hatch that opened inward instead of pushing out, and an electrical short, a spark that ignited the fire.
    2. **Apollo 8**: Jim Lovell was on board this flight and was the first manned orbital flight around the moon.
    3. **Apollo 9**: Earth orbit test of the LEM, Lunar Excursion Module, tested the descent engine, the ascent engine and docking procedures.
    4. **Apollo 10**: Lunar orbital flight, Command module and LEM separate, Lem begins the descent to the lunar surface only to stop short and conduct a planned "abort", never reaching the lunar surface.
    5. **Apollo 11:** July 20, 1969 - First humans to walk on the moon:
        a. **Neil Armstrong**: 1st to walk on the moon.
        b. **Buzz Aldrin**: 2nd to walk on the moon, took communion on the lunar surface
        c. **Michael Collins**, remained in lunar orbit onboard the Command Module while Armstrong and Aldrin explore the lunar surface.
    6. **Apollo 12**: Successful 2nd Lunar exploration, "glitch" occurred when lightning stuck the spacecraft shortly after takeoff. No significant damaged occurred.
    7. **Apollo 13**: Major malfunction, explosion in the oxygen tank in the service module causes this near disaster. Jim Lovell, Fred Haise and Jack Swaggart were on board. Ken Mattingly was bumped by Swaggart two days before the flight because he was exposed to the measles. He becomes instrumental in the successful return of the Apollo 13 crew.
    8. **Apollo 17**: Last manned flight to the moon
iv. **Shuttle Program**

1. Known as the **STS, Space Transport System**, the cargo transport vehicle that takes objects into low earth orbit and to the international space station.
2. Composed of three parts.
    a. **External Fuel Tank** – only part that is not reusable – it falls back to the earth, burning in the atmosphere.
    b. **Two solid rocket boosters** – used to help propel the orbiter into orbit. Once the fuel is exhausted, they are released and parachute back to the Atlantic ocean and reused.
    c. **Orbiter**: the reusable spacecraft that glides back to Cape Canaveral to be used over and over again.
3. In 1981, Columbia became the first orbiter in space.
4. **Challenger** was destroyed by faulty "O-ring" on the solid rocket booster during a cold winter launch. Flames burned through the SRB and ignited the external fuel tank causing catastrophic explosion killing all aboard, including **Kristy McCauliff**, the first "teacher" to be selected to enter space.
5. January 2003, **Columbia** sustained damage to the orbiter wing on take off. Not realizing the problem in time the orbiter disintegrated during reentry killing all on board.

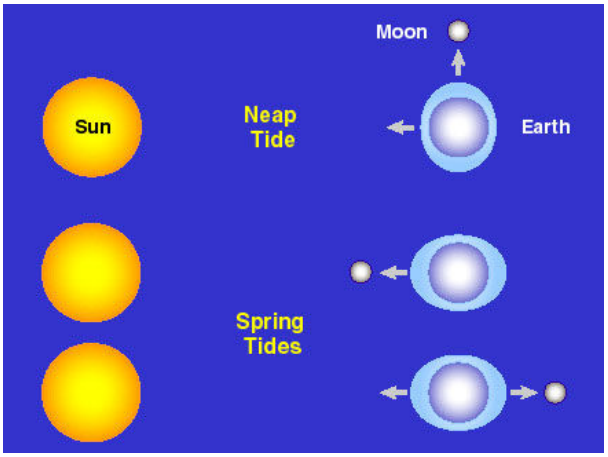
II. The Earth in Space
- a. **Axis** – imaginary line passing through the North and South Pole
- b. Earth's axis is tilted at **23 ½ degrees**
- c. **Rotation**: the Earth spinning on its axis one time – One 24 hour day and night cycle
- d. **Revolution**: The movement of one object orbiting around another in space. One revolution of the Earth around the Sun requires 365 ¼ days…. 1 year.
- e. Seasons:
    i. Seasons occur because of the Axis tilt of the Earth.
    ii. North pole pointed toward the sun results in more direct sunslight hitting the northern hemisphere…. Summer in the northern hemisphere, winter in the Southern hemisphere. **Summer Solstice** usually around **June 21**
    iii. Six months later North pole points away from the sun, less dirct light hits the northern hemisphere… Winter occurs in northern hemisphere, Summer in the Summer hemisphere. **Winter Solstice** usually around **Dec 21**
    iv. **Spring Equinox** – around **March 21**; date there is an equal length of daylight and nighttime hours.
    v. **Autumnal Equinox** - around **September 23**; date there is an equal length of daylight and nighttime hours.

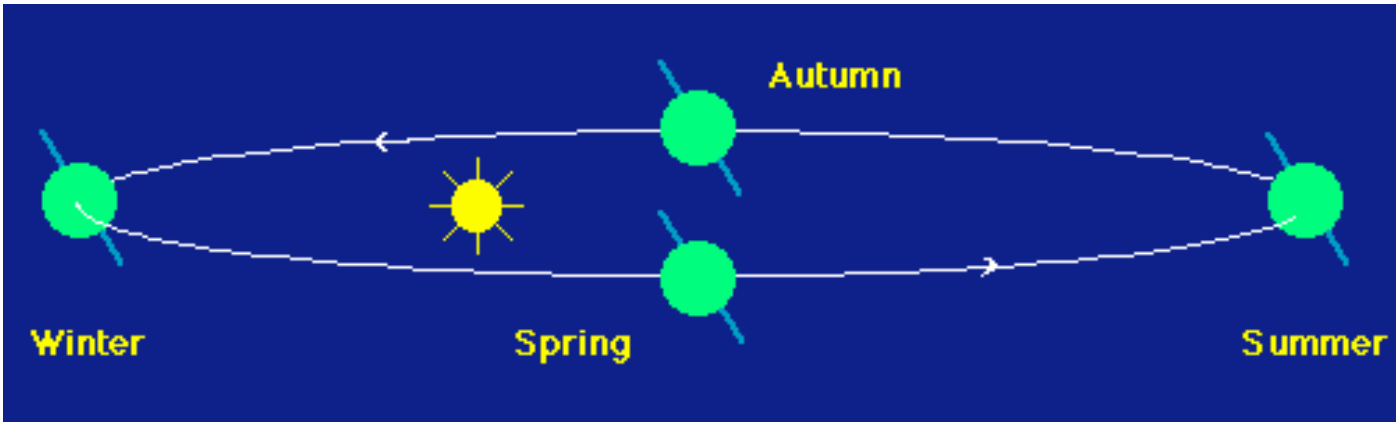
III. Phases, Eclipses and Tides
- a. The moon **orbits** the Earth every **27.3 days** and **rotates** on its axis every **27.3** days. This causes the same side of the moon to always face the earth.
- b. Phases of the moon**: New moon – Waxing Crescent – 1st Quarter – waxing gibbous – Full moon – Waning gibbous – 3rd Quarter – Waning Crescent - New Moon**
- c. Requires approx **29.5 days** to complete the phases
- d. **Eclipses** – moon's orbit is tilted at approx 5 degrees above the plane that the Earth orbits the sun.
    i. When the moon's shadow hits the earth a **solar eclipse** occurs.
        1. When the entire sun is hidden by the moon a **total eclipse** occurs. This happens when the **umbra** part of the shadow falls on the Earth.
        2. When only part of the sun is hidden by the moon a **partial eclipse** occurs. This happens when the **penumbra** part of the shadow falls on the Earth.
    ii. When the Earth's shadow hits the moon a **lunar eclipse** occurs

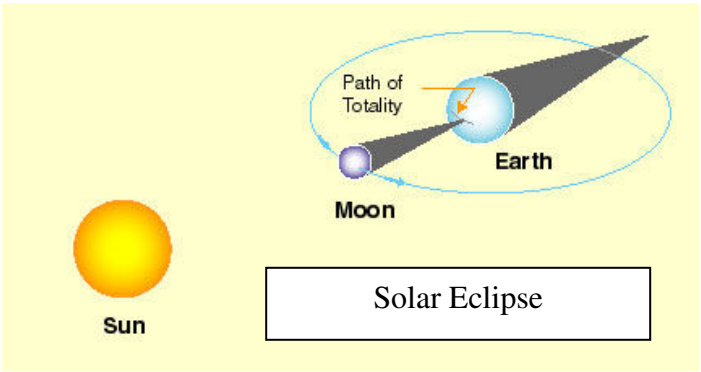
e. Normal Daily Tides –
    i. Moon and Sun gravity play important parts in the cycle of tides on the Earth.
    ii. Moon's gravity plays a strong role in the formation of tides than does the sun's gravity.
    iii. **High Tide**:
        1. Moon's gravity pulls the water on the Earth nearest to the moon towards it. This creates a "bulge" in the water that faces the moon, a high tide.
        2. Another high tide occurs on the opposite side of the Earth because the moon pulls stronger on the Earth than the water farthest from the earth and "leaves this water behind" hence another high tide here.
    iv. **Low Tide**:
        1. Water on the sides of the Earth perpendicular to those two areas closet to and farthest from the Earth are low tide areas of the Earth.
    v. Usually two high tides and two low tides each day
f. Special Tides: Spring and Neap Tides
    i. **Spring Tides**:
        1. When the Sun and the Moon line up together with the Earth, their gravity act together causing extremely high high tides and very low low tides.
        2. Occur during new or full moons
    ii. **Neap Tides**:
        1. When the sun and moon are perpendicular to the Earth their gravity comes close to canceling each other out. Consequently the high and low tides have the least difference in their high and low points.
        2. Occur during 1st and 3rd quarter phases of the moon

IV. Rockets and satellites
a. A rocket moves forward due to Isaac Newton's Law of motion that states: **For every action there is an equal and opposite reaction.**
b. Satellites are used for: Communication, navigation, weather data collection or research.
c. **Geosynchronous orbit**: orbits of satellites that revolve at the exact same rate that the Earth rotates… therefore they remain exactly overtop the same spot on the earth.

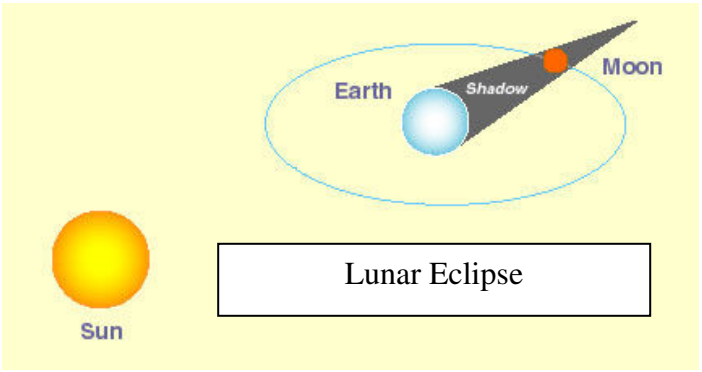
V. Earth's Moon: 250,000 miles away, 1/6 the size of the Earth
a. Origins of the Moon:
    i. **Daughter theory**: During formation of the Earth, the earth spun so fast that the moon was thrown away from the forming Earth and developed into the moon
    ii. **Sister Theory**: The moon formed separately at about the same time as the Earth
    iii. **Capture theory**: a forgein body traveling through space was captured by the Earth's gravity and remains in orbit
    iv. **Collision Theory**: This is the theory that best fits the evidence, when the Earth was very young and consisted of molten rock, a collision with an object about the size of Mars occurred and flung material into orbit. The material collected to form the moon.
b. Features of the Moon
    i. **Craters**: round pits on Lunar surface caused by the collision of the asteroids
    ii. **Highlands**: Mountains on the moon
    iii. **Maria**: Lunar "seas" – not "water seas" but formed after asteroid collisions broke through the thin lunar crust causing magma to flood and fill the craters that were present at the time.



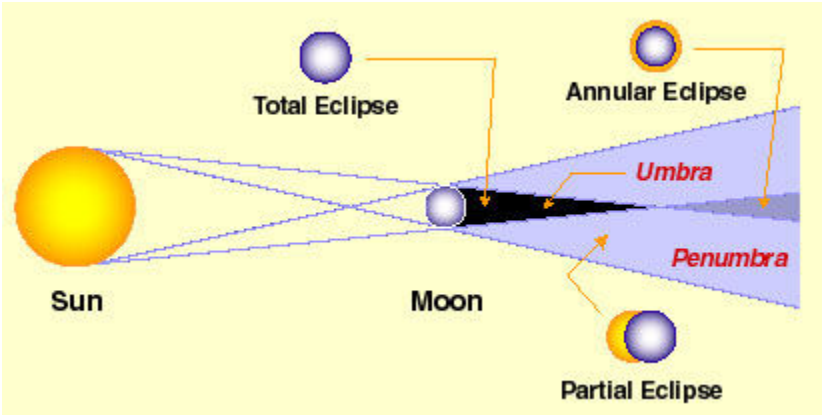




Solar Eclipse



Lunar Eclipse



Phases of the Moon