Chapter 4
The Solar System: Interplanetary Matter and the Birth of Planets

Solar System
* Inventory
  • 1 Sun
  • 5 dwarf planets (__________)
  • 166 moons
  • asteroids
  • comets
  • meteoroids
  • The list will continue to grow

Planetary Properties
* Order of planets
* Sizes of Planets
  * Sun contains 99.9% of solar system's mass
  * Planets are relatively close to the Sun
    * Planetary orbits become more widely spaced with increased distance from the Sun
      • Distance roughly doubles with each planet (____________________)
  * Planets all revolve counterclockwise
  * All planets have nearly the same orbital plane as the ecliptic except Pluto (17°) and Mercury (7°)

Terrestrial and Jovian Planets
* _____________________ (Mercury, Venus, Earth, Mars)
  * Inner planets
  * Closely spaced orbits
  * Small sizes
  * Predominantly rocky surfaces
  * High densities
  * Slower rotation rates
  * Weaker magnetic fields
  * No rings
  * Thinner atmospheres, except Venus
    • Due to low escape velocity - speed needed to escape a planet’s gravity
* Jovian Planets (___________________________________________)
  * Far from the Sun
  * Widely spaced orbits
  * Large masses
  * Large sizes
* Low densities
* Stronger magnetic fields
* Many moons
* Thick atmospheres
  * Due to huge escape velocities

Interplanetary Matter
* Rocky fragment less than 100 m in diameter
* Meteor -
  * Caused by friction heating up an object entering Earth's atmosphere
  * Typically lasts for only a few seconds
  * _____________ - meteoroid that has reached the ground
* Meteor showers -
  * Prominent events calendar
  * Most are sand sized particles
  * Primarily composed of iron and nickel
  * Friction scars the meteoroid’s surface
  * 4.4 - 4.6 billion years
* Over 250,000 known asteroids
* Fragments of rocky material more than 100 meters in diameter
* located between the orbits of ____________________________
  * Revolve counterclockwise, except one
  * Most stay close to the ecliptic plane
  * More eccentric orbits than the planets
  *
  * Remain 60° ahead and behind Jupiter in orbit
  *
  * Most asteroids will remain within the belt
  * Some have highly elliptical orbits
  * Over 3000 known
  * Current map of objects
  * Become deflected by the gravities of Mars and Jupiter
  * Potential for collision is very real
  * most are less than 1km wide, but one is greater than 10 km
  * Icarus (mile-wide) is an Earth-crossing asteroid
* Largest asteroid “Ceres” is 587 miles wide
* Asteroid views
  * close-up view -- Irregular shaped -- Rotating
Asteroids originate from the fragments of broken planets and rocks that never formed organs.

Comets

- Discovered as a faint, fuzzy patch far from the Sun
- They brighten and develop a tail as it nears the Sun
- Have no internal light, only reflected

Comet features

- Nucleus –
  - Only the nucleus exists far from the Sun
- Coma – heated mass forms a gaseous and dusty glow around the nucleus
  - coma gets larger as it nears Sun
  - can be as large as Jupiter
- Tail
  - can stretch a distance of 1 AU
  - 2 tails exist
    - __________ -- straight blue tail of a comet
    - dust tail -- curved white tail of comet

- Hydrogen envelope - engulfs the coma and the tail

Famous comets

- Hyakutake (1998)
  - 76 year period
  - Documented every time since 240 B.C.
  - In 1986, it was probed by ESA
  - Will return in 2061

Origins

- Short period comets originate in the _______________
  -
- Long period comets originate in the ______________
  - Can stretch up to 100,000 AU
  - Surrounds the entire solar system

Comets have highly elliptical orbits

- They get smaller with each pass since they melt a little each time they pass by the Sun

Is Earth on a Collision Course???

- The solar system is cluttered with meteoroids, asteroids, comets, and comet remnants which travel at great speeds
- We know that comets and asteroids have collided with Earth more frequently than 1st expected
- Evidence of impacts
  - Earth is littered with over 100 impact structures called "__________“ and many are very old
  - Winslow, AZ
25,000 years ago
– 1.2 km wide, 0.2 km deep
– Meteoroid was about 50 m wide

- Gosses Bluff (Australia) – 140 million years ago
- Manicouagan Crater (Canada) – 200,000 million

* Recent incidents

- ___________, a spectacular explosion occurred in Siberia from a "fire-ball" brighter than the Sun
  - Shock waves broke windows 1000 miles away
  - Trees were scorched, de-limbed, and flattened up to 19 miles away
  - No impact crater found, nor any metallic fragments
  - Object exploded just above the surface

* Comet Shoemaker-Levy
  - Produced brilliant flashes and dark zones

* Asteroid 2002 MN
  - 100 meter object passed within 75,000 miles of Earth (1/3rd the distance to the Moon)
  - It was detected 3 days after it passed our planet

* Asteroid 2204MN4
  - In April 2029, this object will pass only 15,000 miles above Earth’s surface (15 times closer than the Moon)
  - Has a 350 meter diameter

Formation of the Solar System

* Contraction created heat and pressure
* Sun formed at the hot center
* Giant, cooler swirling matter surrounded
* Cooler regions away from the Sun caused condensation and the formation of proto-planets (proto-planetary disks = ____________)