

The Solar System

What is a solar system - what is in it?

- Planets
- A Star (the Sun)
- Moons (Satellites)
- Asteroids
- Comets

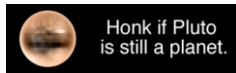
What is a planet?

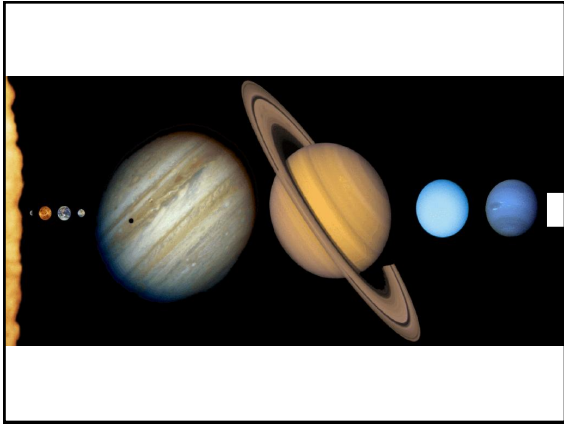
Summer 2006 – IAU “rules”

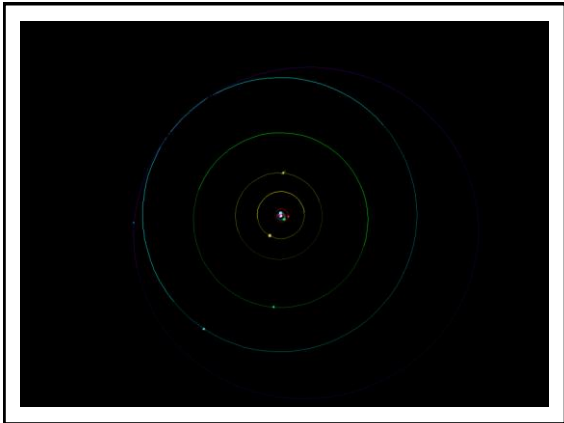
- Must orbit the Sun
- Must be large enough to be spherical
- Must have cleaned out its orbit - Bigger than the other stuff in the same area

How's it arranged? Order of the planets

- Mercury
- Venus
- Earth
- Mars
- Jupiter
- Saturn
- Uranus
- Neptune
- ~~Pluto~~







Terrestrial Planets
Mercury, Venus, Earth, Mars

- Small Mass, Small Radius
- Warm Solid Surfaces
- Dense Rocky Composition
- Inner solar system
- Few satellites
- Atmospheres - large molecules - CO₂, H₂O, O₂, N₂

Jovian Planets

Jupiter, Saturn, Uranus, Neptune

- Large Mass, Large Radius
- No solid surfaces
- Gaseous composition, low density
- Outer solar system
- Many satellites
- Atmospheres - H, He, + molecules (H₂O, CH₄, NH₃)

Formation of the Solar System

Basic Guidelines

- Most mass in the Sun - 99.9%
- All planets orbits near the ecliptic, circular shapes, same direction
- Most rotate in the same direction
- Most satellites orbit/rotate in the same direction
- Density decreases further from the Sun
- More massive planets far from the Sun
- Left over objects (comets, asteroids, etc)
- Lots of craters on planets, satellites and other objects

Basic Ingredients

What is the Solar System made of?

What is the Sun made of?

- | | |
|---------------|-------------------------------------|
| •70% Hydrogen | And where did this stuff come from? |
| •28% Helium | H, He - the Big Bang |
| •2% All else | the rest - Stars |

Step 1 - Solar Nebula



Step 2 - Cloud is spinning. Why?

Angular Momentum - flatten out the cloud into a disk shape



Step 3 - Gravity goes to work.

What is this material like?

Depends upon location.

Close to the Sun - high density (**rocks and metals**)

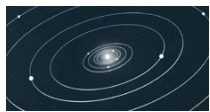
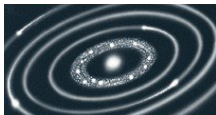
Far from the Sun - light weight (**gas, ice**)

Abundances of material influences masses of final objects

High Density
Rocks, Metals



Low Density
Gases

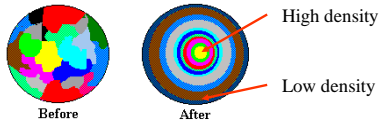


Planet Formation Details

Planets form from small objects (mixed composition)

Planets today are sorted

How did that come about?



Radioactive Decay

Studies of meteorites - a lot of radioactive material

So?

Radioactive decay releases heat.

So?

Melts or makes mobile rocks, metals

Helps the planets become **differentiated** (sorted nice and neat).

Heavy Bombardment

IMPACTS!

Impact onto semi-solid surfaces of the planet/satellites/other objects

The [Heavy Bombardment Era](#).

The first 1/2 billion years.

Big impact craters (Mercury, the Moon, etc.)

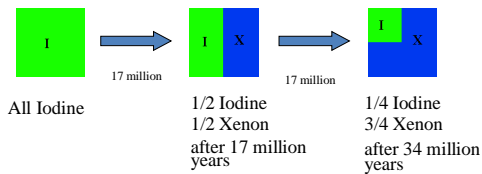


Time-Line

When did all this happen?
 Start of formation around 4.5 billion years ago
 Didn't take very long (few million - 100 millions years)
 How do we know this?
 Radioactive Decay!
 Use **half-lives** to determine ages
 Meteorites date from the earliest times (4.5 b.y.a.)

Half-Lives

What is a half-life?
 The time for **1/2** of the radioactive material to decay.
 Radioactive Iodine 129 decays into Xenon 129 -
 1/2 life of 17 million years.



Clues about Radioactive Material

A large amount of radioactive material tells us -

- A source for this material? Best candidate is a supernova. Does our existence depend upon the death of another star?
- The rocks that made up the large chunks and eventually the planets formed very quickly. A fast formation process.

Other Solar Systems

Currently, ~320 planetary systems discovered
 ~400 total planets
 Expect more discoveries

