This lecture presents an introduction to our Solar System.

The Sun
Terrestrial Planets
Jovian Planets
Dwarf Planets
Giant Moons
Trans-Neptunian Objects
Asteroids, Comets, & Meteoroids

The planets all lie in nearly the same plane and orbit in the same general direction.

We currently live in the Golden Age of Space Exploration.

The Solar System has been explored with robotic spacecraft & astronauts:
- Landed men on the Moon
- Robotic landers on Moon, Venus, Mars, Titan & an asteroid
- Rocks returned from the Moon
- Probed Atmospheres of Venus, Mars, Jupiter, & Titan
- Flown spacecraft by all planets
- Extensive exploration of Mars in progress
- Mapped Venus & Titan with radar
- Flown by asteroids & comets
- Spacecraft on the way to Pluto and the Kuiper Belt
Lecture 22: The Family of the Sun

The Family of the Sun

The Terrestrial Planets:
Rocky Planets: Mercury, Venus, Earth & Mars

The Jovian Planets:
Gas Giants: Jupiter & Saturn
Ice Giants: Uranus & Neptune

Dwarf Planets:
Rocky & Icy Bodies: Pluto, Eris, Ceres, Haumea & Makemake

Small Solar System Bodies:
Icy: Kuiper Belt Objects, & Comets
Rocky: Asteroids & Meteoroids
The Eight Planets all orbit counterclockwise in the same sense as the rotation of the Sun.

All of the Eight Planets orbit nearly in the same plane.

The common sense of orbital motion and nearly co-planar orbits are a dynamical “memory” of the original rotation of the proto-solar nebula.
The Sun is a middle-aged, average star
Mostly Hydrogen & Helium
99.8% of the Mass of the Solar System
~4.6 Gyr old

The Sun shines because it is hot:
Surface Temp ~5800 K
Emits mostly Visible, UV & IR light

Kept hot by nuclear fusion in its core:
Builds Helium from Hydrogen fusion.
Can shine for ~10 Gyr by Hydrogen fusion
another ~1 Gyr via Helium fusion

The Terrestrial Planets are the rocky planets found in the inner Solar System 0.4–1.5 AU from the Sun.

<table>
<thead>
<tr>
<th>Planet</th>
<th>Mass (M⊕)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>0.055 M⊕</td>
</tr>
<tr>
<td>Venus</td>
<td>0.82 M⊕</td>
</tr>
<tr>
<td>Earth</td>
<td>1 M⊕</td>
</tr>
<tr>
<td>Mars</td>
<td>0.11 M⊕</td>
</tr>
</tbody>
</table>

Composed of mostly Silicates and Iron with solid surfaces
All are High Density: 3.9 – 5.5 g/cc (rock & metal)

The Jovian Planets are the giants of the outer Solar System, located 5 – 30 AU from the Sun.

<table>
<thead>
<tr>
<th>Planet</th>
<th>Mass (M⊕)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jupiter</td>
<td>318 M⊕</td>
</tr>
<tr>
<td>Saturn</td>
<td>95 M⊕</td>
</tr>
<tr>
<td>Uranus</td>
<td>15 M⊕</td>
</tr>
<tr>
<td>Neptune</td>
<td>17 M⊕</td>
</tr>
</tbody>
</table>

Composed of mostly gases and ices, with no solid surfaces
All are Low-Density: 0.7–1.6 g/cc (gas and gas+ice)
Jupiter & Saturn are Gas Giants with thick Hydrogen & Helium atmospheres over rock & ice cores.

Saturn:
95.2 ME
9.44 RE

Jupiter:
318 Me
11.2 Re

Jupiter & Saturn are Gas Giants with thick Hydrogen & Helium atmospheres over rock & ice cores.

Uranus and Neptune are Ice Giants made mostly of ices with thin Hydrogen & Helium atmospheres.

Uranus:
14.5 Me
4.51 Re

Neptune:
17.1 Me
3.88 Re

The Dwarf Planets are a new class of Solar System objects defined by the IAU in 2006.

- Eris
- Pluto
- Ceres
- Haumea
- 40+ other candidates…

Moon

Earth
Unlike the planets, the dwarf planets can have eccentric and highly inclined orbits.

The Solar System has 7 Giant Moons, mostly found orbiting the giant planets of the outer solar system.
The Trans-Neptunian Objects are a numerous class of small, icy bodies that orbit beyond Neptune.

Composed mostly of ices: density 1.2–2 g/cc

Icy Dwarf Planets (Pluto, Eris, Haumea, & Makemake)

Kuiper Belt Objects (30 – 50AU)

Pluto’s large moon Charon

Distant large icy bodies like Sedna & Quaoar

Largest known Trans-Neptunian Objects

Asteroids are rocky or rock/metal aggregates found mostly in the Main Belt between Mars and Jupiter.

Made of rock & metal, some with ices (density 2–3 g/cc)

Range in size from a few 100km to large boulders (few meters)
Meteors are small bits of rock and/or metal ranging in size from grains of sand to boulders.

- **Stony Meteors**: mostly silicates
- **Iron Meteors**: mostly iron
- **Chondrites**: high Carbon content and organic compounds including amino acids

Meteor burning up in the Earth's atmosphere.

Comets are low-density composites of rock and ice ("Dirty Snowballs").

- Originate in the outer solar system (Kuiper Belt and Oort Cloud)
- Develop longs tails of gas & dust swept off them by sunlight and the solar wind when they pass near the Sun.