

The Solar System

Chapter 7

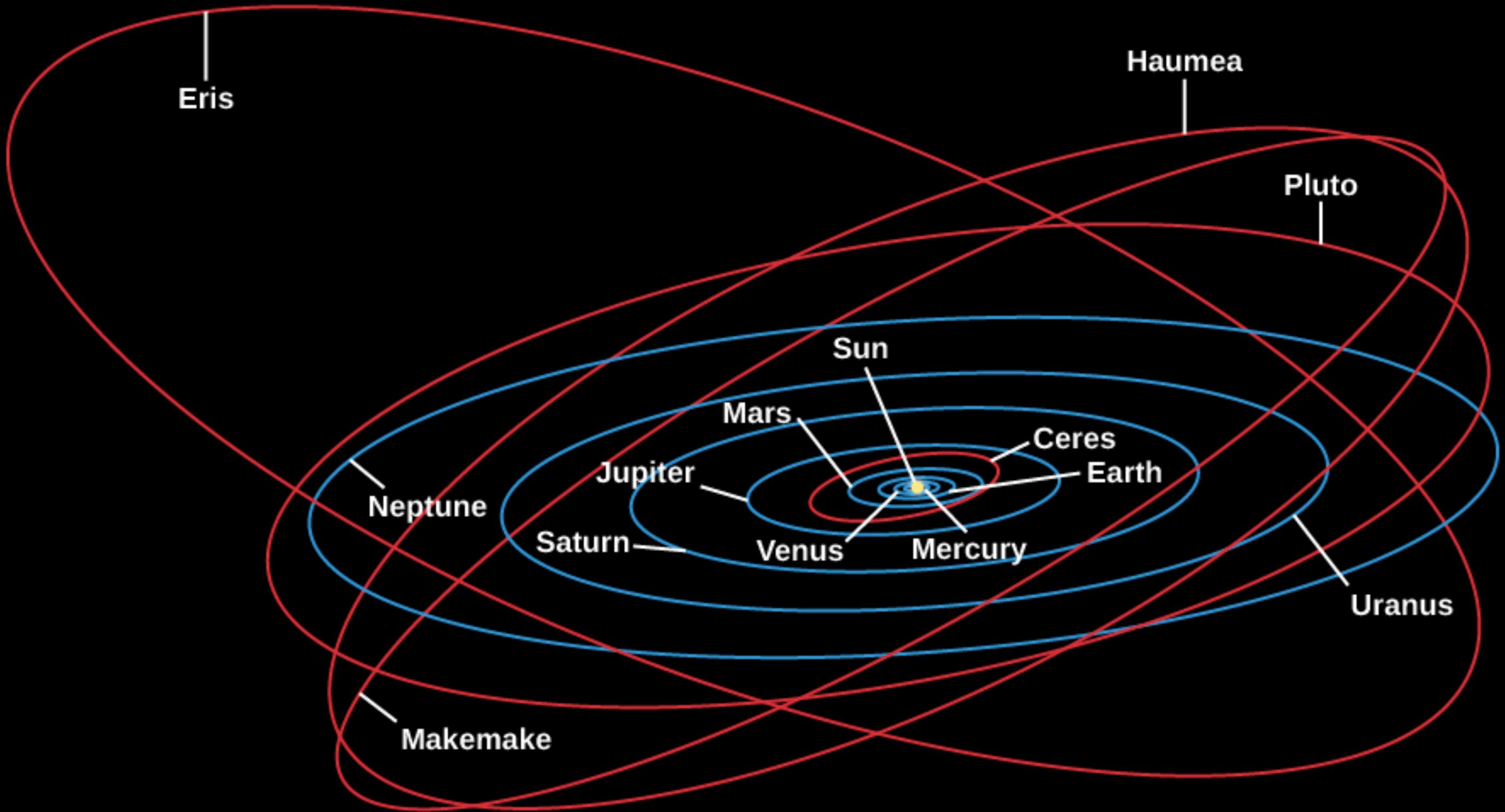
The Solar System

- Our solar system consists of our sun (Sol) and everything else that orbits it including planets, moons, asteroids, trans-Neptunian objects and comets.
- The solar system is 4.5 billion years old as the whole solar system formed as the Sun formed.
- The Sun is 99.8% of the mass and essentially 100% of the radiation in the solar system. From afar the solar system is just the Sun, with little specs floating around it. Jupiter, the largest planet is only 1/1000th the Sun's mass.

Inventory

- The solar system has 8 planets; Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. All the planets revolve around the Sun in the same direction and in a very narrow plane around the ecliptic.
- There are also dwarf planets in the solar system, these are big enough to become spheres because of gravity, but not large enough to clear their orbits of other objects. Ceres is a dwarf planet in the asteroid belt while Pluto, Eris, Makemake, and Haumea are trans-Neptunian objects.
- Trans-Neptunian objects are found out beyond Neptune. There are many thousands of objects out there that orbit the Sun, but they are all smaller than planets. They also tend not to be in less circular orbits and not as close to the ecliptic. Some of them become comets.

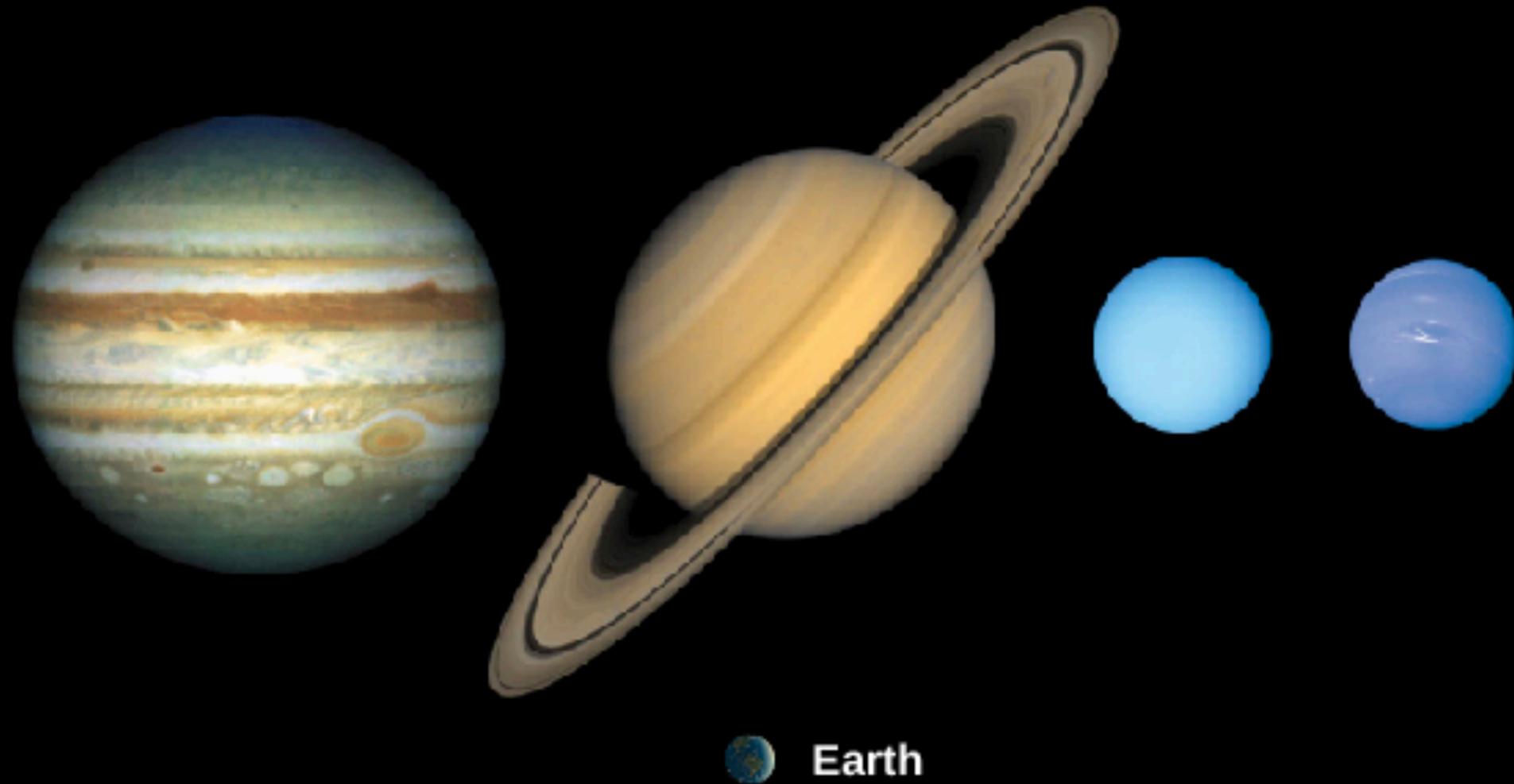
Solar System



Planets

- All of the planets and dwarf planets spin around their axis. Almost all in the same direction as they revolve around the Sun. Only Venus rotates the opposite direction, while Uranus is rotating at almost 90° from the ecliptic.
- Terrestrial Planets - The four inner most planets, Mercury, Venus, Earth and Mars are called the terrestrial or earth line planets. They all have rocky surfaces.
- Giant Planets - The outer four planets, Jupiter, Saturn, Uranus and Neptune are called the giant planets. They are

Giant Planets



The giant planets are larger and more massive than the terrestrial planets.

Smaller Objects

- All of the planets except for Mercury and Venus have moons. While most moons are very small some are almost as large as the smallest planet Mercury. These are Earth's moon, Luna or the Moon, Jupiter's moons, Io, Europa, Ganymede, and Callisto, Saturn's moon, Titan and Neptune's moon, Triton.
- Also all of the giant planets have rings, though Saturn's are the most impressive.

Saturn's Rings



Smaller Objects

- Also there are asteroids, small rocky objects that are mostly found between Mars and Jupiter in the asteroid belt. Some of the smaller moons are captured asteroids.
- Finally there are small objects made of ices (mostly water ice and carbon dioxide ice). These are found far out beyond Neptune and trans-Neptunian objects. But sometimes some of them come near the Sun and melt forming comets.

Astroid Eris



Comet Churyumov-Gerasimenko



Scale Model of Solar System

- It is very hard to grasp the scale of objects in the solar system and we will often show them not to scale so that they can actually be seen. To get a sense of the correct scale we can make a scale model for example reducing all lengths by a factor of 1 billion.
- Then the Earth is about the size of a grape and the moon of a pea that is 40cm away.
- The Sun is the size of a person and 1 city block away from the Earth.
- Jupiter is 5 blocks from the Sun and the size of a large grapefruit.
- Saturn, Uranus and Neptune are 20, 30 and 40 blocks from the Sun and correspond to an orange and two lemons in size.

Composition of Solar System

- The Sun is primarily composed hydrogen (75%) and helium (25%) with less than 1% everything else.
- The giant planets are also mostly hydrogen and helium. Jupiter and Saturn have about the same ratios as the Sun while Uranus and Neptune have more of the heavier elements.
- The terrestrial planets are very different primarily being rock and metal. They all have iron cores and rocky exteriors with varying ratio of rock to iron. Earth's moon is like the terrestrial planets though low in iron.
- Other moons are a mixture of rock and ice. Because they are so cold ice is always frozen so these are both solids. They tend to have rock/metal in their cores and ice on the exteriors.

Temperature in the Solar System

- In general temperatures decrease the farther away one is from the Sun. Remember the flux from the Sun decreases as distance squared.
- In addition to distance the composition of the atmosphere can strongly affect the surface temperature of a body. CO_2 in the atmosphere keeps the heat in making Venus and Earth hotter than they would be without atmospheres.
- Venus is actually hotter than Mercury because of its atmosphere, and the oceans on Earth would be frozen if not for ours.

Geological Activity

- All the bodies in the solar system are occasionally hit by meteoroids. This was much more common in the beginning of the solar system and the number of craters from meteoroid impact that we see on a surface can be used to date it.
- Some objects in the solar system have other geological phenomena like volcanoes or valleys. This was more common in the past, but now many objects interiors have cooled down and they no longer are geologically active.

Formation of the Solar System

- The solar system formed with the formation of the Sun. Later we will see how stars form from collapsing gas clouds.
- When that cloud collapses it flattens into a disk because of angular momentum conservation. In the disk small dust grains grow into small rocks that collide to form planetesimals. These mostly orbit in the same direction.
- Eventually most of the planetesimals merge to form planets, though some are left behind and we now call them asteroids, or trans-Neptunian objects.