The Solar System

The word ‘solar’ comes from the Latin word for our Sun, ‘Sol’. So Solar System is the collective word for all the objects that orbit our Sun, including the Sun itself.

It is timely to remember that until recently, it was generally believed that our Solar System was the only such system. Now we know that there are many Non-Solar Systems, or Extra-Solar Systems – systems of planets around other stars. So, more than ever, the term ‘Solar System’ has come to mean our system, as we assume those other stars have different names, not Sol.

Initially, until the telescope was invented in 1609, astronomers only knew of six planets, including Earth. Of course, until the Helio-centred cosmology was accepted after Galileo, Earth was not thought of as a planet – it was Earth, our home and the centre of the Universe and those orbiting it were the planets. Now we know that is not the case and Earth is ‘just’ one of the planets circling the Sun. (Helios was the Roman sun god, traveling across the sky in his golden chariot.) Those six planets were: Mercury, Venus, Earth, Mars, Jupiter and Saturn.

It’s slightly ironic that if the ancient astronomers had paid a bit more attention to the fainter stars, they may have noticed another ‘wanderer’ in the sky, the faint but just naked eye visible Uranus, so they could have marveled over seven planets. However, the discovery of the seventh and eighth planets Uranus and Neptune had to wait till the invention of telescopes and were discovered in 1781 and 1846 respectively.

The Solar System comprises the following family members:

- The Sun
- Eight planets (4 terrestrial type, 4 gas giants)
- The asteroid belt (which includes some Dwarf Planets)
- The Kuiper Belt Objects (which include Pluto and other Dwarf Planets)
- The Oort Cloud of comets

Our star, Sol, the Sun, is an average size main sequence star halfway through its ten billion year life. Despite the apparent size of the larger planets and the huge number of asteroids, Kuiper Belt Objects and the Oort cloud of comets, the Sun accounts for more than 99% of the total mass of the Solar System.

The Asteroid Belt is generally located in a band between the orbits of Mars and Jupiter. It comprises a huge number of rocky ‘worlds’, well over 10,000 (and counting), most very small, but many of significant size. For example, Ceres (the largest known) is 940km in diameter and has been classified as a Dwarf Planet (like Pluto). Others are Vesta (580km) and Pallas (540km), Gaspra (17km long, non-spherical), Ida (55km long) and Eros (33km long) and many more. These asteroids are a genuine concern to us, as many have orbits bringing them very close to Earth at some future time. An object as large as, say, Ida hitting Earth would be a real ‘extinction level event’.

Beyond the orbit of Neptune lies the Kuiper Belt, a collection of icy bodies, most smaller than Pluto, but some larger. This belt’s existence was suggested by Gerard Kuiper in 1951. Its existence was confirmed in 1993, 20 years after Kuiper’s death. Pluto, now called a Dwarf Planet, is the best known of the KBOs. Others are Quaoar, Eris (temporarily known as Xena), Ixion and Veruna. The Kuiper Belt is the source of short term comets, those with periods of less than 200 years and extends in a belt ranging from 30 to 100 astronomical units from the Sun.

Beyond the Kuiper Belt lies the vast spherical cloud of icy cometary bodies called the Oort Cloud, named after its proposer. It is believed to be populated by thousands of millions of comets, some of which are nudged by gravity to fall towards the Sun as long period comets (more than 200 years). Due to its distance – about one light year from the Sun - none of its individual comets can be seen, even by the most powerful telescopes.

Apart from the spherical Oort Cloud, most of the Solar System's members lie in or very close to the flat ecliptic plane which is the plane of Earth's orbit about the Sun. Some, like the KBOs, have orbits with significant inclinations to this plane. (Pluto, for example, has an inclination of 17 degrees.) However, the planets have inclinations mostly within 2 or 3 degrees of the plane, with the exception of Mercury with the largest inclination of 7 degrees.

The orbits of the eight planets also have varying levels of eccentricity, which is a measure of how 'non-circular', or elliptical, its orbit is. A perfect circular orbit has an eccentricity of 0 (zero). With the exception (again) of Mercury with an eccentricity of 0.2056, the other planets vary from 0.00681 (Venus – almost perfectly circular orbit) to 0.0933 (Mars). Earth has an almost-circular eccentricity of 0.0168.

As you would expect for a system of planets formed from the gravitational condensation of a rotating cloud of gas and stellar debris (contributed to by the remnants of previous stellar explosions creating the heavier elements we are all made of, as well as the dominant hydrogen and helium of the universe), all the planets orbit the Sun in the same direction as the Sun's own rotation about its axis. That is, they orbit anti-clockwise about the Sun as seen by an observer looking down on the Solar System from a point in space above the Sun's north pole.

Where does our Solar System fit in to the bigger picture? Our Sun is just one star in a galaxy, the Milky Way, with an estimated 300 billion stars and a diameter of about 100,000 light years. The Milky Way is a spiral galaxy, believed to have a bar across its core, making it a 'barred spiral' with a system of spiral arms. Our Sun is located in the so-called Orion Arm of the galaxy and is about 30,000 light years out from the galaxy's centre and 20,000 light years from the outer edge. The Milky Way rotates once in about 250 million years. While this may make our location in space seem very crowded, remember that the next closest star to us is Alpha Centauri at a distance of 4.3 light years. That's 43 trillion km.

Just how crowded is our Solar System? What are the chances of collision? To put it into perspective, consider the following simple model:

Suppose our Sun was a large ball only 1.4 metres diameter (instead of its actual diameter of 1.4 million km). Then:

- Our Earth would be a 1.3 cm ball at a distance from the Sun of 150 metres.

- Jupiter would be a 14 cm ball 780 metres from the Sun (almost a km).

- Neptune would be 5 cm ball 4.5 km from the Sun.

- Alpha Centauri, a pair of large balls like the Sun, would be 41,400 km away.

That's a lot of empty space in between when you imagine it like that. Now increase the scale by 1 billion to get back to reality.

The table below gives just some key dimensions of our Solar System. For more details of each planet, refer to the accompanying articles.

Object	Equatorial Diameter (km)	Mean Distance from Sun (x 1000 km)
Sun	1,392,530	-
Mercury	4,879	57,856
Venus	12,104	108,132
Earth	12,756	149,492
Mars	6,794	227,780
Jupiter	142,984	777,776
Saturn	120,536	1,425,983
Uranus	51,118	2,867,760
Neptune	49,528	4,492,800