THE PLANETS IN OUR SOLAR SYSTEM

By
William Reville, University College, Cork.

Nine planets orbit the Sun. Other orbital components of the solar system include asteroids, comets and rings of interplanetary dust. Until as recently as 30 years ago, astronomers knew relatively little about the planets, with the exception of our own Earth. Much more is now known and acquisition of knowledge has been greatly assisted by the various space probes.

There are nine major planets and they are usually divided into two groups, the inner planets and the outer planets. In moving outwards from the Sun, you meet the planets in the following order: Mercury, Venus, Earth and Mars (the inner planets), Jupiter, Saturn, Uranus, Neptune and Pluto (the outer planets). The inner planets are small and are mainly composed of rocks and iron. With the exception of Pluto, the outer planets are large and mainly composed of hydrogen, helium and ice. So, we can divide the planets into rocky dwarfs and gassy giants.

Mercury, Venus and Mars are similar in density to earth and must be composed largely of rock, and possibly with iron cores. The next four planets, Jupiter, Saturn, Uranus and Neptune are much larger than Earth and have much lower densities than Earth.

Saturn has such a low density it would float in water. The low density means that these planets must be composed mainly of gases and liquids. Tiny Pluto is at the edge of the solar system and is probably composed of a mixture of rock and ice.

Mercury has only a transient atmosphere and its surface is still scarred by the bombardment of asteroids it received early in its history. Carbon dioxide is only a minor constituent of the Earth's atmosphere, but the atmosphere of Venus consists almost entirely of carbon dioxide (96%). This causes such a large greenhouse effect that the surface temperature of Venus is the hottest of all the planets - 477^{o}C.

The only planet with abundant liquid water and life is Earth. We earthlings long entertained notions that Mars harboured life - even intelligent life. Around the turn of this century Percival Lowell made detailed observations of the planet and formulated a theory of an advanced civilisation on Mars that had built an elaborate system of canals in order to use scarce water supplies for irrigation purposes.

Lowell also predicted the presence of a planet beyond Neptune, which was discovered in 1930 and named Pluto. Although the concept of a Martian civilisation did not survive Lowell's death in 1916, the idea that biological life exists on Mars was widely accepted for most of the twentieth century. However, this notion was finally disproved by the Viking mission to Mars in 1976. There is no evidence for the existence of life on Mars now, although the planet may have harboured life in the past. And, almost certainly, there is no life anywhere else in our solar planetary system outside of our own beautiful Earth.

Although there is evidence that Mars once had liquid water on the surface, the carbon dioxide atmosphere is now so thin that the planet is dry and cold (average temperature minus 55^{o}C, with polar caps of solid carbon dioxide (dry ice). About half of Mars is heavily cratered, but the rest is different, with vast volcanoes and canyons larger than anything on Earth. In terms of the age of the solar system there has been recent geological activity on Mars - lava flows and water

erosion have erased the older craters.

Among the giant planets (Jupiter, Saturn, Uranus and Neptune), Jupiter and Saturn are supergiants. Together they contain over 90% of the mass of all the planets. Both planets are composed predominantly of hydrogen and helium. Models indicate that both planets have rocky cores. Both planets have intricate ring systems and satellites.

Detailed observations have been made of the rings around Saturn, Neptune and Uranus by the Voyager spacecraft. The rings of Uranus and Neptune are very narrow (a few km thick) and they orbit the planets at a distance of around 50,000km. The broad rings of Saturn are composed of thousands of narrow 'ringlets', nestling together one inside the other. The rings are composed of millions of lumps of ice, ranging in size from a few millimetres up to a few metres.

Astronomers have pieced together the story of how the solar system was formed. About four and a half billion years ago a cloud of gas and dust collapsed under its own gravity to form a clump at the centre which became our Sun, and a swirling disc of dust and gas (hydrogen and helium) which later formed the planets. The dust consisted of tiny grains of ice and rock. Closer to the sun the heat evaporated most of the ice particles, leaving the rock grains. This explains why the planets near the sun are rocky.

Further out from the Sun the icy particles survived and the planets Uranus and Neptune are composed of rock and ice (melted). Saturn and Jupiter began in this way, but became so big that their gravity captured hydrogen and helium from the disc, and they now consist principally of these gases.

Planets are thought to have started to form when dust particles clumped together to form ‘planetesimals’, a few km wide. The planetesimals in turn merged to form the planets. After the 9 main planets were formed they quickly swept up most of the remaining planetesimals. The impacts made by the colliding planetesimal are evident in the cratering still visible on all the old surfaces that have survived in the solar system. This old cratering is no longer visible on Earth, having been gradually removed by geological erosion.

There is evidence that our Moon was formed when a body about the size of Mars crashed into the Earth. The collision threw out a spray of molten rock from Earth, that condensed into particles which in turn aggregated to form the Moon.

(See table below.)

THE MAJOR PLANETS IN OUR SOLAR SYSTEM

	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
Average distance from sun (million km)	58	108.2	149.6	27.9	778.3	1427.0	2869.6	4496.7	5900
Diameter (km)	4878	12103	12752	6794	142800	120660	51400	49400	2280
Mass (Earth = 1)	0.06	0.82	1.0	0.11	317.8	96.1	14.5	17.2	0.002
Density (Water = 1)	5.4	5.3	5.5	3.9	1.3	0.7	1.2	1.7	1.99
Number of satellites	0	0	1	2	16	20+	15	2	1
Magnetic field (Earth = 1)	0.01	0.0	1	<0.01	14	0.67	0.1	?	?
Time to orbit Sun (yrs)	0.24	0.62	1.0	1.88	11.86	29.46	84.01	164.79	247.7

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