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Large planets – little moons

There are regularities in the masses of moons of the outer planets in the solar system, says S.Ananthanarayanan.

These are the kind of things that scientists piece together to guess what might have been the way the planets and their companions formed. This week's ***Nature*** reports work of scientists at the Southwest Research Institute, Boulder, Colorado, which suggests that the moons of Jupiter-size planets in outer space may be of the Moon – Mars size, a useful datum for the possibility of human colonies!

Planets and moons

The planets all have their own satellites, like the earth's moon, Phobos and Deimos of Mars or the 16 satellites of Jupiter. Some of the moons are ***regular***, or moving around the mother planet in the same direction as the planet is rotating, while some of the moons are ***irregular***, or going round the other way. The irregular moons are thought of as 'captured', rather than formed out of the same material as the mother planet itself, which is the way the regular moons are imagined to have formed.

The planets are broadly of two kinds. The first kind is the ***terrestrial***, or earth-like kind, which are Mercury, Venus Earth and Mars. These four planets are smaller, about the earth's size, have the inner orbits, closer to the sun and are rocky in composition. The other group of planets is Jupiter, Saturn, Uranus and Neptune, the giants, with large, outer orbits, composed mostly of hydrogen, as ice and gas, they have rings and a host of satellites. Pluto is an odd one out both far out and small in size – it falls into neither category.

Ratio of masses

In the case of the giant, gaseous planets, a remarkable regularity is noticed in the mass of the regular moons around the planet, as a fraction of the mass of the planet itself. Here is a table of this feature in Jupiter, Saturn and Uranus:

Name of the planet	Mass of moons/mass of the planet
Jupiter	2.1 x (1/10,000)
Saturn	2.6 x (1/10,000)
Uranus	1.1 x (1/10,000)

It is remarkable that the ratio is of the same order, 1/10,000 in all three cases. This is unlike the terrestrial planets, where the largely rocky moons have masses that are a much larger fraction of the mother planet – 1/1000 for the earth's moon or just 1/10 for Pluto's moon. The Earth's moon is an exception, as considered to have been 'captured', rather than co-evolved. Mercury and Venus have no moons and the moons of Mars are also an exception, being very small

Features like this are the signposts, or *pug marks*, that help scientists correct their course as they grope towards working out how the solar system formed, and from that to work out things about the universe, and then to test the laws of science that govern so much right here on earth.

Explaining the ratio

Robin M Canup and Willam R Ward, under a project sponsored by NASA, modeled the twin processes of satellites in growth and decay as a giant gas-rich planet collects gas and rock-ice solids, as it forms within the solar orbit. The model considered the inflow of material from a circular disc around the mother planet, as the planet itself is forming from the disk around the sun. Balancing this inflow is the loss of material from the satellite because of centrifugal forces as the satellite material spins and is affected by spiraling gases and other complexities. The scientists used numerical methods, which is computer simulations as well as analytical methods, which is mathematics and theoretical modeling, to refine the assumptions.. The results have shown that the satellite to planet mass ratio always comes to around 1/10,000 in the case of gas giants.

A consequence of this discovery relates to extra solar systems, where the current interest is to trace earth-like planets. Even if detection of earth-sized planets remains elusive, it may be sufficient to detect Jupiter-sized planets, because this kind of planet is then likely to have a satellite of about the right size!