appeared on 15th Apr 2006

Changing partners in the cosmos

Planets in the early solar system did a tag dance, says S.Ananthanaryanan.

This week's ***Nature*** reports that one of the difficult things about the moons of Neptune gets explained with this kind of satellite formation.

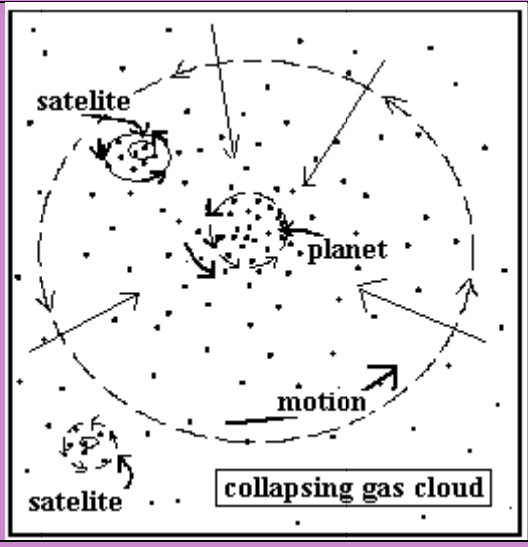
Neptune's moons

Thirteen moons of Neptune have been discovered so far. Some of the moons are so close to the planet that they cannot be made out in telescopes and three of this kind were discovered by the spacecraft Voyager 2 only in 1989. And yet another three were discovered as recently as 2002!

The most interesting of the thirteen moons is perhaps Triton, the seventh moon, which is the largest and peculiarly going round Neptune in the direction opposite to the direction of Neptune's spin. And as a large and massive body, it is one of the only three satellites in the solar system that have their own atmosphere. (the other two are Jupier's IO and Saurn's Titan). Triton, in fact, is 40% more massive than Pluto, which is a full-fledged planet.

So what's the mystery?

The theory of how the solar system came about is that when the sun was forming, in a process of a gas cloud collapsing into itself by gravity, the slow turning of the cloud led to faster and faster rotation as the cloud got smaller - rather like a spinning ballerina turns around faster when she draws her outstretched arms inwards.



And in this twirling and collapsing of matter, some parts formed into separate bodies, by their own gravity, even before they reached the centre – and thanks to their motion, they stayed in orbit, to become the planets. The whole thing must have been quite violent and not very symmetrical and the massive bodies also ended up with rotation and precession and all kinds of complicated motion as they went around the sun.

An extension of the same process could then explain how the moons of the planets were formed and this is the theory that is accepted for much of the solar system. Some similarity of the mineral content of planets and moons, the existence of asteroids and comets, and the Kuiper belt, a ring of particles that did not collect into a planet, but go around the sun in orbits outside Neptune's, support this way of thinking.

But the trouble with the orbit of Neptune's Triton is that its motion is in the opposite sense of the rotation of Neptune itself. When a cloud of matter spins around as it collapses, it is not possible to have 'two-way traffic', with some matter flying one way and some the other. There would be collisions and friction and very soon, all the matter would share the same sense of motion.

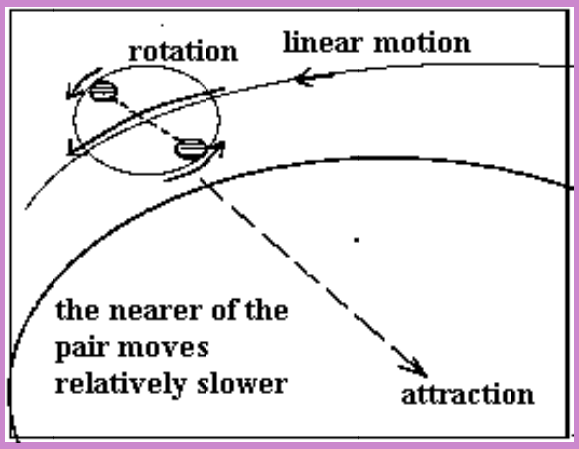
Retrograde moons

The theory for these 'opposite sense' moons (or planets) is then that they did not form during the collapsing of the system but that they were external bodies passing by, which were 'captured' by gravity. Given a small enough object, it is conceivable that it may stray into the gravity of a larger object and get 'trapped'. This, in fact, is the theory for our own moon, and the moons of Mars. But the problem with Neptune's Triton is that the Triton is far too massive for this theory. Working out the mathematics of how such an object could be wandering about the solar system, maybe in a trajectory of many light years, and attracted by the sun, but got trapped in a near circular orbit throws up myriad problems.

Another theory is that Triton may have collided with one of Neptune's existing moons and smashed it to small pieces. Triton then lost so much momentum that it slowed enough to fall into an orbit around the planet. The problem with this theory is again Triton's mass, which comes in the way of working things out.

The *Nature* report

Craig Agnor, from California and Alessandro Morbidelli, from Nice, France report that they have found a way out - the mathematics works nicely if Triton is taken to have been a member of a pair of bodies, in orbit around each other, like a spinning dumbbell, that strayed near Neptune. Such pairs, called binaries, are quite common in the cosmos – in fact the planet Pluto is actually one of a pair, the other member being Charon, an object of almost the same mass.



Normally, when an object approaches a large planet, it is moving so fast when it gets close enough that it just whizzes past, and goes far into space. But when the object is a spinning pair, the backward spin of one member may compensate its speed of motion and the object may be slow enough to get captured. The other object, moving the other way, would speed straight on and the first member could ***change partners***!

"We conclude that Triton was once a member of a binary and was captured as it made a close approach to Neptune", the writers say.