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MOONS AND TIDES

Ken Tapping, 11th February, 2014

For centuries the only moon we could see details on was ours. The moons of other planets were dots or at most tiny discs, even through our largest telescopes. We tried to guess what they were like using our Moon as an example. However, we did not consider something that is equally familiar to us, especially if we live by the ocean – the tides.

Our ideas were based on the idea that the only thing warming up the moons of the planets in our Solar System is sunlight. Therefore, as we get further from the Sun, we would expect moons to get colder and colder. Moons orbiting beyond the orbit of Mars would be cold enough for water to be perpetually frozen – just another rock mineral. Further out, gases would also become liquids. Finally, far out from the Sun, all gases other than perhaps helium would be solids. The moons orbiting far from the Sun would be dark, very cold, and devoid of any life forms we could visualize.

Then, in the 1970's we started sending space probes out through the Solar System to see the outer planets and their moons close up, and got a lot of surprises. Some of the moons turned out to be as expected, while others were definitely not.

Our Earth and Moon pull at each other. Since the gravitational attraction increases rapidly with decreasing distance, the Moon pulls at the oceans on the side of Earth facing it more strongly than it pulls at the Earth, so the ocean is pulled up into a bump, and the land up into a much smaller bump. It also pulls the Earth more strongly than the ocean on the other side, so the Earth is pulled away from that ocean leaving it to form a second bump. As the Earth rotates, we pass through one of those bumps every 12 hours. We see this as the ocean level rising and falling twice a day – the tides. This kneading of the Earth and oceans liberates heat, and is gradually slowing the Earth's rotation. The Earth has done the same thing to the Moon, with the result that the Moon no longer rotates with respect to the Earth, and we see the same face of the Moon all the time.

The tidal situation is far more spectacular for the moons of the giant planets. Io is the closest moon to Jupiter. Since it lies so far from the Sun, we would expect it to be frozen, but the tidal forces exerted on it by the giant planet kneads the moon so strongly that the heat released drives great volcanoes, spewing forth lakes of molten sulphur and other materials. Io is the most volcanic object in the Solar System. Europa, the next moon out, is less strongly heated. However, there is enough heat to maintain under a thick layer of ice a deep, dark ocean. Some of this heat is likely to drive hydrothermal vents on the ocean floor, just like the ones on the beds of our deep oceans. Here on Earth those vents support communities of strange animals; this could also be the case on Europa, hence our great interest in that world. Ganymede and Callisto, although further from Jupiter, are still suspected to have oceans under their icy surfaces.

Titan, Saturn's largest moon, has a smoggy atmosphere loaded with nitrogen and hydrocarbons, with hydrocarbon lakes and rivers on its surface. Enceladus, another of Saturn's moons is suspected of being similar to Europa.

Titania and Oberon, two of the larger moons of Uranus, the next planet out from the Sun, are suspected to have liquid water inside them. Triton, the largest moon of Neptune, the eighth planet out from the Sun, has active volcanoes on its surface, ejecting material kilometres into space.

Two of the lessons to be learned from this are firstly, in putting together theories we often do not pay enough attention to the obvious, and secondly, there is absolutely no substitute for going out there for a close look.

Venus rises about 5am. Jupiter, second only to Venus in brightness, still dominates the sky for much of the night. Mars rises around 11pm and Saturn at 1am. The Moon will be Full on the 14th.

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