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WRONG ABOUT MOONS

Ken Tapping, 31st March, 2015

Things don't have to be out in the far reaches of space for our ideas about them to be wrong. Until quite recently we had no idea how scientifically interesting moons are. We knew that most planets have them. In our Solar System only Mercury and Venus don't have any. Our idea was that moons are basically balls of cratered rock that are too small to retain atmospheres. In the case of moons orbiting planets in the outer Solar System, there would be ice too, as a permanently frozen rock mineral. There were anomalies. For example, Titan, the planet Saturn's largest moon, has an atmosphere, but that is the only one that does. Another puzzle was Io, Jupiter's closest moon. Astronomers, many of them amateurs, have reported that moon to exhibit regular, short-lived changes in brightness. Rock balls can't do that.

If you have a rock ball with no atmosphere at a certain distance from the Sun, it is fairly easy to estimate what its temperature should be. Questions on this subject turn up in university exams. The calculations show, as expected, that as we get further from the Sun, those rock balls get colder, and somewhere beyond the orbit of Mars, they should be permanently frozen. The picture is logical, tidy, and incorrect.

When the two Voyager spacecraft went out through the outer Solar System and on into interstellar space, they sent back images of moons orbiting the outer planets, and we realized we had to do some more thinking. Io is covered with sulphur volcanoes; Europa, the second closest moon to Jupiter, is sheathed in a thick envelope of ice, which may have a deep, dark ocean underneath. Ganymede, the third closest, may have a less pronounced version of the same thing. Now it is being suggested that Callisto, the fourth moon out from Jupiter, may not be a simple ball of rock and ice. It might also have a hidden ocean.

Saturn's moon Titan has a thick atmosphere, made out of nitrogen and hydrocarbons. On its surface there are rivers and lakes of liquid ethane

and propane. Luckily, it is too far away – at the moment – to be of commercial interest. Even out as far as Uranus and Neptune, the gas giant planets orbiting in the outer Solar System, there are moons with ice volcanoes, where water occasionally flows out like lava, and jets of water vapour squirt out. What we are seeing does not fit our calculations at all. Are they wrong?

Actually, no. It is just that there is a strong effect the simple temperature calculation leaves out. Moons orbiting close to large planets are distorted by tidal forces. The part of the moon closest to the planet is gravitationally pulled more strongly than the rest of it, so it gets pulled into an egg-shape. If that moon is also rotating on its axis, it is continually being forced to change shape. This generates a huge amount of heat. Io is close to Jupiter and tidal heating is strong enough to melt the rock below the surface of the moon. Europa is further away, and the effect is less, but still enough heat to maintain that hidden ocean.

Here on Earth there are geothermal vents (black smokers) on the beds of the deep ocean. They support communities of living creatures that do not depend on sunlight. It is very likely there are similar vents on moons like Europa, possibly supporting communities of exotic creatures.

It seems a bit odd that the best sites in the Solar System to look for life are probably the moons of distant, giant planets, so far from the Sun that it is simply a very bright star in their skies. That's why there are proposals to send a spacecraft to land on Europa. It will drill a hole through the ice and launch a robot submarine explore that alien ocean. Its appearance will give the locals a shock!

On the 4th the Moon will be Full and there will be a partial lunar eclipse visible from Western Canada. Check the sky between 4 and 5am. Venus lies in the southwest after sunset. Jupiter dominates the southern sky and Saturn rises around midnight.

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