

A close look at Venus – some clarity, more mystery

'Earth-like' planets are being discovered in around distant stars. How promising is that, when nearby Venus, so similar to earth, is yet inhospitable to life

Space probe results have begun to explain how Venus, the Earth's neighbour lost its store of water, says S.Ananthanarayanan.

Venus is not just the earth's immediate neighbour in the solar system, Venus also has almost the same size, mass, density and time to go round the sun as the earth. But still, while the earth has conditions where life has prospered, Venus is a furnace, at 457 C – hot and dry with scarcely any water vapour, and an atmosphere made of carbon dioxide weighing down with pressure 92 times that on the earth. It looks like a planet needs a lot more than just being 'earth-like', when seen from hundreds of light years away, to be anywhere near life supporting!

Venus Express mission

The Venus Express is the European Space Agency's exploration spacecraft, in orbit around Venus and collecting scientific data since April 2006. Venus Express is an adaptation of the earlier Mars Express, which reached Mars in 2005 and has carried out extensive studies of the Jovian atmosphere and surface. But there are differences, for example, because Venus is half the distance from the Sun, compared to Mars, the radiant heating of the craft is four times greater. The ionization radiation is also harsher. The construction thus needs to be more robust. On the other hand, being nearer to the sun, the illumination of the solar panels is better and the craft has more electric power for its manoeuvres.

Mars Express was well equipped for investigating the planet's surface, even to send down Beagle-2, a probe that landed on the planet to work on-the-spot. But Venus Express works entirely from orbit and has special devices to study the Venus atmosphere and clouds in detail. For instance, it has the ASPERA-4, or "Analyzer of Space Plasmas and Energetic Atoms" which studies the impact of the solar wind on the atmosphere. Or the MAG, the magnetometer to study how the solar wind affects the planet's magnetic field.

Objectives and results

The major objective is to see why Venus is so unlike the earth. On the earth, three fourths of the surface is covered by oceans and the total water is three hundred times more massive than the atmosphere. But on Venus, there are no oceans and the water vapour is only a trace in the atmosphere. Both planets have roughly the same quantities of nitrogen and carbon dioxide. The CO₂ on the earth is in the form of carbonates in limestone, etc., but on Venus, most of it is in the

atmosphere. That makes the atmosphere pretty dense, and the pressure is 92 times that on the earth.

Where has the water disappeared, what is the atmosphere like and why is the weather so different from on the earth? Maybe, because of Venus being so much closer to the Sun, the water evaporated into the atmosphere. Water vapour is a greenhouse gas and this would have led to more warming and more evaporation, which would lead to more warming and so on, till all the water resided in the atmosphere.

What could have then happened is that the strong sunlight split the water molecules into hydrogen and oxygen. As lighter atoms in a gas move faster, the hydrogen atoms gradually escaped into space, while the oxygen remained to oxidize the planet's crust.

Verification

A handy indicator of this mechanism becomes available because of the nature of hydrogen atoms. There are two forms of the hydrogen atom, one with only one proton and the other, called heavy hydrogen, which has a proton and a neutron. As the heavy hydrogen atoms would move much slower than normal hydrogen, and not escape as fast, it is expected that in time, the hydrogen in the atmosphere would have more heavy hydrogen than before.

That the hydrogen left in the Venus' atmosphere is indeed richer in heavy hydrogen was roughly verified by NASA's Pioneer mission in 1978. But instruments aboard Venus Express have now confirmed this accurately.

Venus Express has also sent down other surprising results about the atmosphere. As the atmosphere is more massive than the earth's, it should store and distribute heat efficiently. Day-night temperature differences should then be lower. This had been confirmed by the Pioneer findings, but Venus Express' radio wave detectors show large temperature differences within Venus' clouds.

The dense material of the atmosphere and the slow rotation of Venus (once in 177 earth days) throw up more surprises in the way winds and currents behave. Here again, Venus Express has found things that were not expected and are difficult to explain. Once such is lightning – there should not be lightning on Venus and indeed, no flashes have been seen. Still, Venus Express has detected low frequency electromagnetic waves that could arise from lightning activity!
