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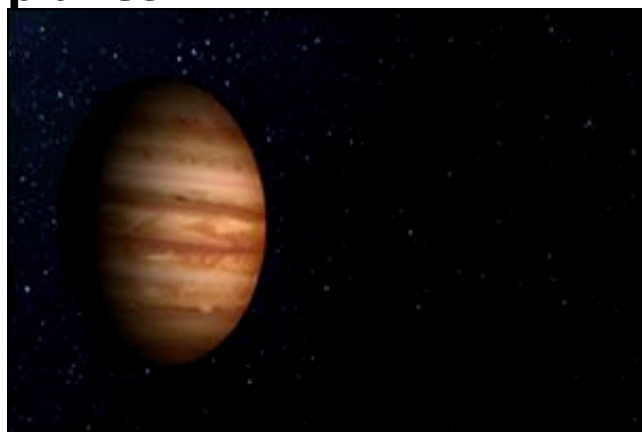
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By Jupiter! Confusion over planet



Jupiter may once have been much further from the Sun

**By BBC News Online Science Editor
Dr David Whitehouse**

A new analysis of the data collected by the Galileo spacecraft's atmospheric entry probe has thrown into confusion the accepted ideas about how our Solar System was formed. The probe plunged into Jupiter's atmosphere in December 1995.

According to scientists writing in the journal *Nature*, gas giant Jupiter has two to three times more of the heavy

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gases argon, krypton and xenon than would be expected had it formed solely from gas left over after our Sun's birth.

It has also about three times more nitrogen than would be expected under the prevailing models of how our Solar System was created.



Jupiter's current orbit, about five times the distance from the Earth to the Sun (five Astronomical Units), is much too warm to have accumulated those gases in the quantities detected by the probe.

The Galileo entry probe was crushed as it descended

Current wisdom has it that Jupiter formed from the solar nebula, the gas and dust left over after the formation of the Sun. It grew due to the accumulation of small bodies called icy planetesimals, or micro-planets.

Most planetesimals, a class of objects which includes comets, are thought to have formed somewhere between the orbits of Uranus and Neptune, 20 to 30 Astronomical Units from the Sun.

But even at that distance the initial temperature of these icy worldlets would have been far too warm for them to trap the heavy noble gases and nitrogen in an icy form.

So where did Jupiter get these heavy

gasses?

One suggestion is that these gases were delivered to Jupiter by small icy bodies that lie beyond the orbit of Neptune in an area called the Kuiper Belt, which is more than 40 Astronomical Units from the sun.

But there is a problem with this idea. Had the planetesimals somehow fallen from their current orbits in the Kuiper Belt to Jupiter's present orbit, the heavy noble gases and the nitrogen would have largely dissipated in the warmer temperatures before they arrived at Jupiter.

Profound implications

Astronomers realise that the presence of the heavy gases on Jupiter are telling us something profound about the origin of the planet and indeed of all the planets in our Solar System.

"The implications are enormous," said one of the authors of the report, **Sushil Atreya** of the University of Michigan College of Engineering.



The probe dived into these clouds on Jupiter

Perhaps, wonder the astronomers, Jupiter was once much farther from the Sun and that it moved in to its present orbit more recently? It is either that, or the solar nebula was much, much colder than astronomers have estimated, said another member of the team, Professor Thomas Donahue.

The puzzling measurements were made by the Galileo entry probe that detached from the main Galileo spacecraft in the summer of 1995 and made a fiery hour-long plunge into Jupiter's windy atmosphere on 7 December 1995.

Before being burned and crushed on its descent, the probe took atmospheric chemistry measurements with a mass spectrometer. The data was relayed to the orbiter passing by high above.

Migrating planets

Its findings, coupled with the recent discovery of planets in other systems that appear to be much larger than Jupiter and much closer to their stars, may lend support to the idea that gas giants can migrate from one spot to another in their solar systems.

"This is a piece of information that's got to be factored in," Professor **Atreya** said.

"If Jupiter had migrated inward, it would have had to come from way out there, 40 or 50 astronomical units," he said. And the Kuiper Belt currently does not have enough mass to account for something the size of Jupiter being formed or the amount of heavy elements now found within the planet.

To add to the mystery of what happened in the outer solar system billions of years ago, some theorists have even proposed that a Jupiter-sized object could be lurking undetected out in the Oort Cloud, a

thin shell of comet-like objects four trillion miles from the Sun.

What astronomers would now like to find out is whether the same thing true of Saturn, Uranus, and Neptune.

Professor Donahue summed up the puzzlement: "There may be more to the Solar System than we know about."

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