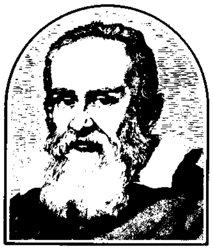
SECTION 7



PROBE SCIENCE RESULTS

Under surveillance by telescopes here on Earth as well as the Hubble Space Telescope, observations of Jupiter show that the probe apparently entered the highly variable atmosphere of Jupiter near the southern edge of an infrared "hot spot." All the instruments operated successfully. The return of the probe mission data, stored in the orbiter's computer memory and tape recorder, was completed in April. Scientists reported their preliminary results at a January 22 press conference. By March 18, 1996, in time for the Lunar and Planetary Science Conference in Houston, Texas, they had arrived at their current understanding.

What did we learn from the probe data? Comprehensive analysis will take years. At this time, we can look at the preliminary findings; they give us some answers to the character of Jupiter's atmosphere—and even more questions.

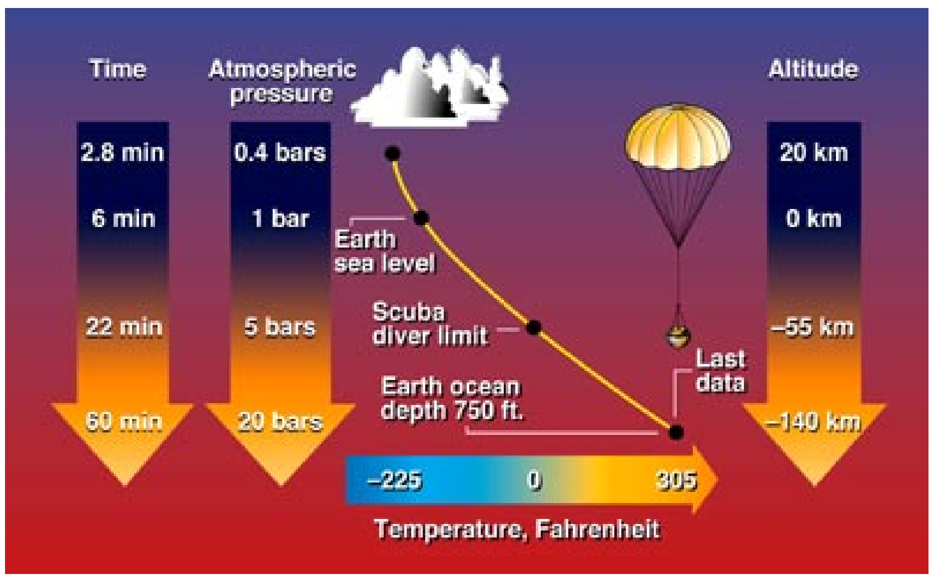
An Artist's View of the Probe's Descent

Atmospheric Structure

The pressure, temperature, and density structure measurements by the atmospheric structure instrument (ASI) during descent are fundamental to understanding Jupiter's atmosphere and essential in the interpretation of results from the other experiments.

Temperatures in the upper reaches of the atmosphere were much higher than could be accounted for if sunlight were the only heating source; some other source of heat must exist. Pressure readings in the upper atmosphere also show a region more dense than predicted. In the lower regions, temperature increased with pressure about as expected, although at a slightly lower rate. This implies that deeper regions of Jupiter's atmosphere may not be convective as previously thought. Scientists look to the probe data to better understand the influence of internal heat pouring forth from Jupiter's core.

Structure of Jupiter's Atmosphere



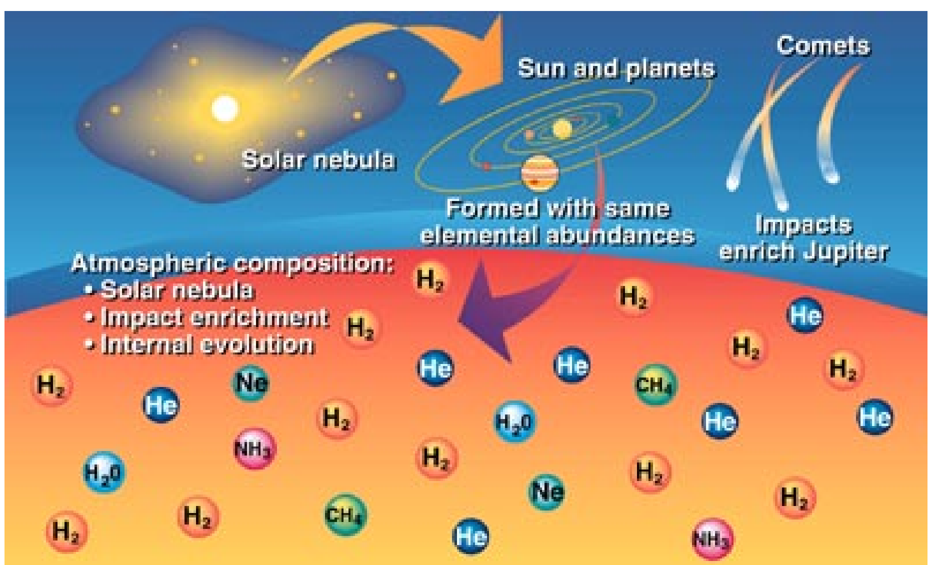
Helium Abundance

Data from the helium abundance detector (HAD) reveal that Jupiter's atmosphere is 13.6 percent helium, close to that of the Sun. Scientists think that this data is representative of the nebula from which the solar system formed. This implies that helium has not rained down or settled toward the center of the planet as much as it seems to have done on Saturn, where the ratio is only 3 percent. The theory of planetary evolution must now take into account the fact that there has been little change in helium abundance in the Jovian atmosphere since the birth of the solar system.

Chemical Composition

The neutral mass spectrometer (NMS) detected the presence of heavy elements—carbon, nitrogen, and sulfur—suggesting that meteorites and other small bodies have contributed to the planet's composition. Few complex organic compounds (based on carbon and hydrogen) were evident so the likelihood of finding life as we know it here on Earth is extremely remote. Evidently, the atmosphere of Jupiter is much drier than anticipated. Rather than finding an oxygen abundance twice or more that of the Sun (based on Jupiter's water content), it appears that the oxygen abundance of the Jovian atmosphere is less than or about one-fifth that of the Sun. Oxygen is highly depleted relative to the abundance on the Sun, a result that will force new ways of thinking about Jupiter's formation and evolution.

Composition: A Tracer for Planetary History



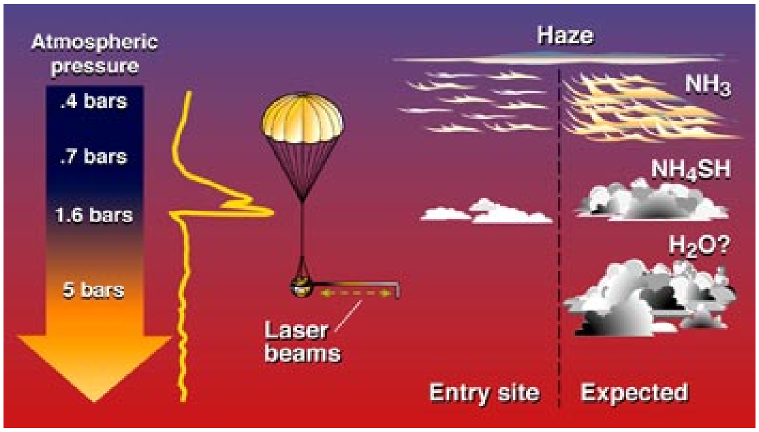
Clouds

The nephelometer (NEP) data surprised scientists. None of the expected thick, dense clouds were found! Concentrations of cloud particles and haze in the immediate vicinity of the probe were minimal. NEP's laser beam detected only one distinct cloud structure, possibly the expected ammonium hydrosulfide cloud layer. Yet observations from Earth and Voyager indicate that Jupiter is enshrouded with clouds. Scientists thought there would be three cloud layers: an upper layer of ammonia crystals, a middle layer of ammonium hydrosulfide, and a thick bottom layer of water and ice crystals. It may be that the probe site was not typical.

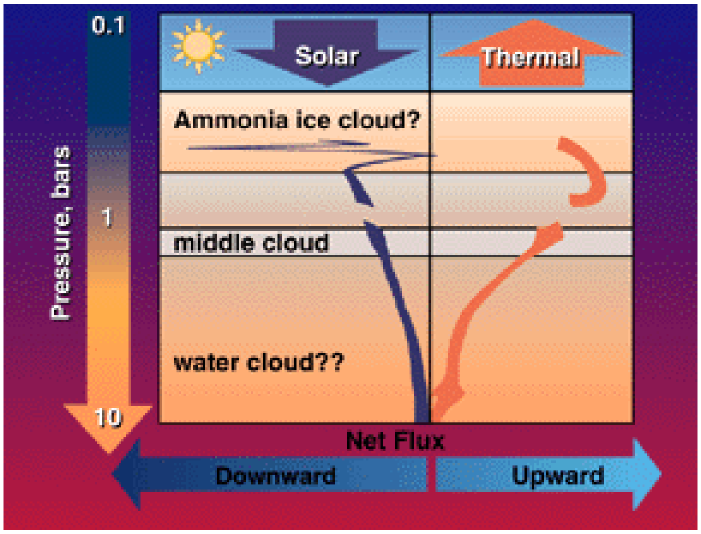
Thermal/ Solar Energy Profiles

The net flux radiometer (NFR) apparently detected the bottom part of the ammonia cloud layer by measuring the decrease in direct sunlight as the probe descended. These clouds would have been at some distance from the probe. The NFR infrared radiative flux channels measured energy fluxes consistent with the dry atmosphere.

Jupiter's Clouds



Net Radiation Fluxes



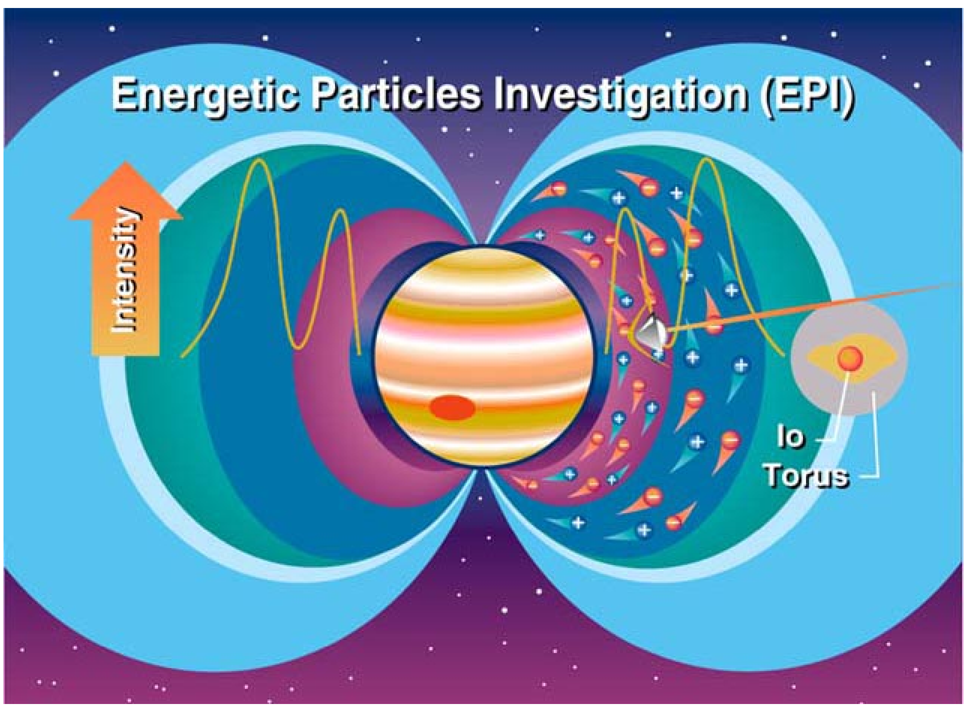
Lightning

The lightning and radio emission detector found no evidence of lightning flashes in the vicinity of the probe. Radio signals revealed distant discharges—perhaps one Earth diameter away but much stronger than those on Earth. Apparently lightning is 3 to 10 times less common per square kilometer per hour than on Earth. Since lightning is believed to produce organic compounds, these findings support the dearth of such molecules found by the neutral mass spectrometer.

A New Radiation Belt

As the probe passed through the region between Jupiter's ring and the upper atmosphere during the 3 hours before entry, the energetic particle instrument (EPI) made a surprising discovery. It detected high-energy helium atoms (source unknown) and a radiation belt about 10 times as strong as the Earth's Van Allen radiation belts. A study of this phenomenon will give scientists new insight into the high-frequency radio emissions from Jupiter and other objects in space that also have magnetospheres and trapped radiation.

Energetic Particles Investigation

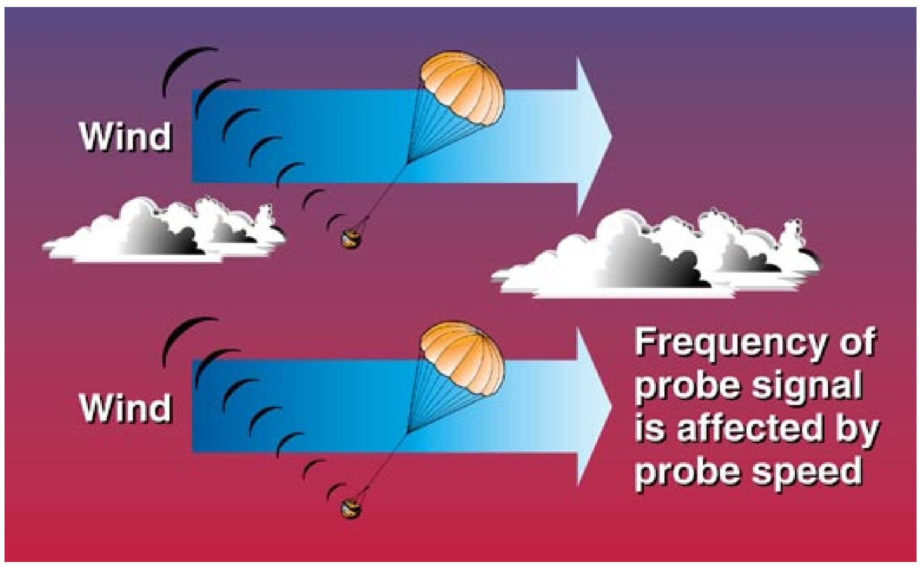


Strong Winds

Finally, the Doppler wind experiment indicated that zonal (east–west) wind speeds near clouds levels are about 540 kilometers per hour (330 miles per hour). Winds just as powerful exist at the top of the clouds, according to Hubble Space Telescope observations. Until the probe descent, the wind activity below the clouds had been hidden from view. Using the Doppler effect, the changes in the frequency of the radio signal from the probe as it floated downward amidst turbulent currents told the story of vertical variation in wind strength.

Toward the end of the mission, deep winds sustained 680 to 720 kilometers per hour (425 to 450 miles per hour). This consistency in wind speed suggests that the intense heat radiated from the interior of the planet is responsible for the strong winds.

The Doppler Effect



An Atypical Entry Site?

Were conditions at the probe entry point typical of the atmosphere? To find out more about this, the measurements acquired by the six probe instruments will continue to be studied and will be augmented by a broad range of data from orbiter science instruments during the Jovian tour.