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PIONEER SATURN RESULTS ARE SUMMARIZED

NASA's Pioneer 11 spacecraft continues to work well after successfully flying past Saturn, the most distant planet yet reached in U.S. exploration of the solar system.

The space probe is now heading out of the solar system after returning the first closeup pictures of Saturn and making a number of important scientific findings, including the discovery of two new outer rings and possibly a new Saturnian moon. In addition, Pioneer sustained no damage from high-velocity ring particles showing that spacecraft can operate safely in the vicinity of the visible rings.

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After a six-year trip of more than 3.2 billion kilometers (2 billion miles) in space, Pioneer spent 10 days photographing and measuring the ringed planet. As it made its closest approach, Sept. 1, to within 20,800 km (13,000 mi.) of Saturn's cloud tops at a speed of 114,500 km/hr (71,200 mph) some 1.6 billion km (1 billion mi.) from Earth, Saturn's gravity swung it almost 90 degrees on a change of course toward the edge of the solar system.

Without a failure, Pioneer can return useful data until the late 1980s, when it reaches the limit of its radio contact with Earth.

Major findings about Saturn are:

• Saturn has an 11th moon. It was discovered in a photo taken of the outer edge of Saturn's rings and by instrumentation on board the spacecraft. Its estimated diameter is 400 km (250 mi.). It has been named 1979S1.

• Saturn has a magnetic field, magnetosphere and radiation belts. It joins Earth and Jupiter as a magnetic planet.

• Because of the low temperature measurements, evidence for the possibility of life on the planet's satellite Titan was discouraging, but not eliminated.

• Two new rings have been identified. One, which has been called the F ring, is separated from the A ring by a 3,600 km (2,240 mi.) gap, called the Pioneer division. The F ring was clearly visible in a closeup picture taken some 943,000 km (586,000 mi.) away from the planet. A second ring, the G ring, also was discovered and lies between the orbits of the satellites Rhea and Titan or about 500,000 km (312,500 mi.) from the cloud tops.

• A feature called the French Division, a division between the middle and inner visible rings (B and C rings), was seen in Pioneer pictures of the shadow of the rings on Saturn's surface. It was named after French astronomers who first suggested its presence.

• Substantial particle material was seen in Cassini's Division and in the outer and inner portions of the A ring. The Cassini Division looks empty when viewed from Earth, i.e., from the sunlit side of the rings.

• The B ring was found to be so opaque that it allowed almost no light to pass through it.

• The C ring was found to have few particles and appeared as diffuse as Cassini's Division.

• Pioneer found no evidence of either an innermost D ring or the expected outer E ring.

• Preliminary measurements of the ring mass indicate they have a low density. This suggests they are made up largely of ice.

• A substantial glow of atomic hydrogen was found around the rings which suggests absorption of protons from the radiation belts caused dissociation of water ice in the rings.

• Pioneer sustained two meteoroid hits above the rings and three more hits below the rings.

• Gravity field measurements indicate that Saturn is flattened about 10 percent at the poles by its rapid rotation and is not an oval body. It has a depression at midlatitudes of about 120 km (99 mi.).

• Gravity field analysis and temperature profile measurements suggest that the planet's core, extending out about 13,800 km (8,575 mi.) from the center, is about twice the size of the Earth, but is so compressed by Saturn's huge mass that it contains about 11 Earth masses of material, largely iron and rock.

• Above the core, out about another 21,000 km (13,125 mi.), the measurements suggest that the planet consists of liquid metallic hydrogen, which does not exist on Earth. The presence of liquid metallic hydrogen is supported by the discovery that the planet has a magnetic field. To produce this field, a planet needs fast rotation and a liquid electrical conductor in its interior -- in Saturn's case, liquid metallic hydrogen.

• Two and half times more heat is radiated into space by Saturn than is absorbed from the Sun. One interpretation of this observation is that perhaps only a third of Saturn's heat is generated by leftover heat of planet formation and by continuing gravitational contraction, with most heat being generated by denser helium sinking through the planet's liquid hydrogen interior. The upper atmosphere was determined to be 5 C (41 F.) warmer than expected.

• Saturn's magnetic field is 1,000 times stronger than Earth's and 20 times weaker than Jupiter's. The field is unique because its north-south axis lines up with Saturn's rotation axis, unlike the 10 degree tilt to the rotation axis of Earth, Jupiter and the Sun.

• Saturn has a magnetosphere, a magnetic "bubble" in the solar wind which surrounds Saturn, which is larger than Earth's, but smaller than Jupiter's. The nose of the tear-drop-shaped magnetic envelope is usually about 1,250,000 km (775,000 mi.) from the planet. Its width is about 3,400,000 km (2,100,000 mi.).

• The planet has radiation belts made up of high energy electrons and protons which are comparable in intensity to those of the Earth, although the region they occupy is about 10 times larger. They are several hundred times weaker than Jupiter's.

• The radiation belts are completely eliminated by Saturn's rings because their high energy particles mirror back and forth between Saturn's poles about once a second, finally striking ring material which absorbs them. This is the most radiation-free sector of space yet found in the solar system.

• The moons Janus, Enceladus and Tethys also absorb large numbers of radiation belt particles.

• Closeup pictures showed Saturn's cloud tops, unlike Jupiter's, have few details.

• Saturn's cloud tops appear to be lower at the poles than at the equator. As a result polar clouds were seen ranging from dark blue to slightly green and changing to brownish belts around 55 degrees latitude.

• There appear to be jet streams around 70 degrees latitude and overall the planet appears to have more and narrower belts and zones than Jupiter.

• Infrared instrumentation showed the equatorial zone cooler than adjoining higher latitude regions and clouds of this zone are, therefore, probably higher. This suggests height and temperature differences between the belts and zones as expected.

• Ultraviolet instrumentation may have detected a generalized hydrogen glow or the presence of auroras on Saturn.

• Titan was found to have a cloud top temperature of -198 C (-324 F.). This very cold temperature eliminates an internal heat source as a means of warming Titan's surface, but leaves the possibility of atmospheric heating from a greenhouse effect.

● Light from Titan was found to be strongly polarized which is expected to allow determination of the kinds of aerosols or particles believed to be in the satellite's atmosphere.

● The ultraviolet instrument found a hydrogen cloud around Titan. This suggests its methane atmosphere is slowly breaking down into hydrogen and carbon, with the hydrogen escaping into space and carbon-based aerosols falling to the surface.

● Pioneer measurements are providing an improved mass and diameter for Titan. These measurements are expected to provide a density determination and estimates of its interior. Its density is believed to be low enough for it to contain significant quantities of interior ice.

● Titan has a magnetic wake within Saturn's magnetosphere. It extends ahead of the satellite instead of behind it, because of the planet's fast magnetosphere rotation.

The Pioneer program is directed by the Office of Space Science, NASA Headquarters, Washington, D.C. Project management is the responsibility of NASA's Ames Research Center, Mountain View, Calif. The spacecraft was built by TRW Systems, Redondo Beach, Calif.

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