Cassini Drops In

After 23 years of limited Earth-based observations, a spacecraft has returned to Saturn and, unlike the Pioneer 11, Voyager 1, and Voyager 2 flybys from 1979 to 1981, Cassini intends to stay awhile, at least 4 years or 74 orbits, to collect information about the planet’s atmosphere, its elusive magnetosphere and ionosphere, the rings, and the moons. This special issue covers the observations made during approach (December 2003 to June 2004), during the ring plane crossing and orbit insertion (1 July 2004), and the first few orbits (July through December 2004).

The Cassini spacecraft (with 12 instruments) with its companion, the Huygens probe (with 6 instruments), was launched from Cape Canaveral on 15 October 1997. The massive mission, about 5650 kg, needed three major gravity assists and 7 years to reach Saturn. It looped around the Sun twice, boosting its orbit for a final gravity assist from a close flyby of Jupiter in December 2000. During the Jupiter flyby, the Cassini instruments were turned on to measure properties of the jovian system, with spectacular results.

After the flyby, Cassini began its fall toward the ringed planet. On 11 June 2004, Cassini flew within 2071 km of the outermost moon of Saturn, Phoebe: its closest and only approach to this satellite. Phoebe is covered with craters signifying an ancient surface and consists of a mixture of rock and water ice with an unexpectedly high porosity. On 1 July 2004 Cassini fired its main rocket engines to slow down the spacecraft, so it could drop into a stable orbit. As the spacecraft was slowing down, it glided over the rings and obtained unprecedented details of their structure and chemistry during the only close ring plane crossing of the entire mission. New moons were found within ring gaps; new rings were mapped; fine-scale ring structures were puzzled over; clouds of oxygen suggested tenuous ring atmospheres; and other data suggested that the rings formed from recycled bits of the moons, making the rings second- or perhaps even third-generation offspring of their parent planet.

During the ring plane crossing, Cassini made its closest approach to Saturn, coming within 18,000 km of the gas giant. Before, during, and after this close approach, instruments tracked lightning associated with storms, clouds, vertical wind shears, and thermal variations in the atmosphere. These observations enigmatically imply that Saturn’s rotation rate has slowed by about 6 min since 1981. Saturn’s atmosphere is richer in carbon than Jupiter’s atmosphere, which is consistent with planet formation by core accretion. A radiation belt was discovered inside of the D ring, the external magnetic field has changed, the current sheet within the magnetosphere is thinner and more extended, and ion cyclotron waves indicate a dynamic plasma.

After Cassini’s closest approach to Saturn, the spacecraft dropped down through the large gap between the F and the G rings into a stable orbit. The size and angle of this orbit will change over time to allow Cassini to visit many moons and sample the rest of the saturnian system to develop a more complete three-dimensional model of the system’s dynamics. Cassini plans to do more than drop by; it will stay awhile.

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