Unveiling the Mysteries of Saturn

By Barb Sande

The weather at Cape Canaveral was clear and quite warm in the hours before dawn on Wednesday, October 15, 1997. Powerful lights bathed Launch Complex LC-40 as the countdown continued for Titan launch vehicle TIVB-33 and its Centaur TC-21 upper stage. A very special payload awaited liftoff: The massive Cassini spacecraft and its companion Titan moon explorer, Huygens. At 4:43 am Eastern Time, the SRMUs (Solid Rocket Motor Upgrades) on TIVB-33 roared to life and Cassini/Huygens began its incredible journey to Saturn. [Photo 1]. The launch and spacecraft support teams from around the United States and from many other countries cheered as TIVB-33 cleared small clouds near the pad and accelerated across the sky. Approximately 48 minutes later, after two Centaur upper stage engine burns, the spacecraft successfully separated to begin its long journey to the ringed planet.

The Cassini/Huygens spacecraft was the largest exploration spacecraft ever launched by NASA, weighing over 12,000 pounds at liftoff. Cassini was named after the Italian/French astronomer Jean-Dominique Cassini (1625-1712), who discovered four of Saturn's moons and observed the rings. The Huygens probe honors Dutch astronomer Christiaan Huygens (1629-1695), who discovered the moon Titan. Cassini's size and outer solar system destination necessitated the use of the powerful Titan launch vehicle and Centaur upper stage, but it was still incapable of reaching Saturn directly, at nearly 900 million miles from Earth. Cassini also required an elaborate feat of navigation, a gravity assist trajectory that took the spacecraft by Venus (twice), back by Earth and finally past Jupiter on December 30, 2000, at last arriving at the Saturn system on July 1, 2004. [Photo 2] Cassini passed through the ring plane and went into orbit around Saturn; Cassini uses the large moon Titan as its focal point for the many orbits around the planet in its primary four-year mission and current follow-on missions.

Science began in earnest at arrival. Cassini has twelve scientific instruments that are used to examine Saturn, the rings and its moons in a variety of light conditions and light spectra (visible, infrared, radio waves, radar, ultraviolet) and also examine plasma fields, dust particles and the magnetosphere of the planet. Cassini relies on nuclear power for its electrical systems and to heat the instruments, because of its destination in the outer solar system. The spacecraft uses three large Radioisotope Thermoelectric Generators (RTGs) that power the systems and components, creating electrical energy from the heat decay of Plutonium Dioxide. In addition, 157 small Radioisotope Heating Units on the spacecraft provide heat for the instruments and components. Prior to launch, NASA and its contractors performed many special analyses and impact assessments to ensure the safety of this system. Cassini was not the first spacecraft to use RTGs, nor is it the last, but it does have the largest nuclear system flown on any spacecraft so far, relying on more than 70 pounds of Plutonium 238.

One of the first major tasks after arrival was the deployment of the European Space Agency Huygens probe, a small probe with a parachute system and six instruments that descended through the thick Titan moon atmosphere on January 15, 2005. Huygens sent back reams of data on the atmosphere of Titan and survived over an hour on the frigid surface. Titan, the second largest moon in the solar system, is of great interest to scientists because it is the only major moon with a thick atmosphere that includes many of the compounds that were present during the development of life on Earth, although conditions are much different in terms of sunlight and surface temperatures. [Photo 3]. As of January 2011, Cassini has performed 73 fly-bys of Titan, some at very close range. Cassini has also performed close and distant fly-bys of many of the other moons (62 moons at last count) and has done extensive monitoring of the ring system and the planet itself.

So what has Cassini discovered during its four-year primary mission, the two-year solstice mission and in its current equinox mission that ends in 2017? The findings are exhaustive and will keep scientists busy for decades; a few highlights include:

1) Titan has liquid lakes of ethane and methane, with associated weather systems ("methane" rains) and significant geological features, including possible "cryovolcanoes" (very cold temperatures) and hydrocarbon sand dunes.
2) The enigmatic moon Enceladus has an internal liquid water ocean, vents liquid water containing organic compounds from its southern pole region, has some of the youngest surface features of any solar system moon and creates the ghostly E-ring with its emissions. Enceladus and Europa (in the Jupiter system) are of great interest to scientists looking for life elsewhere in the solar system. [photo 4]
3) The rings are extraordinarily complex, with clumps of materials, tiny shepherd moons in the gaps, many small ringlets and even the presence of a tenuous atmosphere.
4) Saturn itself has huge, long-lasting electrical storms, atmospheric "waves" and bizarre hurricane-like structures at both poles.
5) Other moons of Saturn have unique features, including Iapetus (contrasting dark and light hemispheres and huge, linear mountain ranges), Mimas (significant surface temperature variations), and the icy moons of Rhea and Dionne (organic materials).

Cassini is one of the last "great planetary exploration missions", in the same category as the Viking Orbiters/Landers, the two Voyager Spacecraft and the Galileo mission to Jupiter. Under development for nearly twenty years and surviving numerous budget cuts, Cassini and its companion spacecraft Huygens represent the culmination of rigorous systems design and development activities by agencies, companies, universities and individuals in 17 nations and 33 states. Lockheed Martin was a major contributor to this incredibly successful program, providing the launch vehicle, spacecraft integration and the main propulsion system for Cassini. For more information about Cassini, including the latest news, go to http://saturn.jpl.nasa.gov/index.cfm

Submitted by Barb Sande (barbsande@comcast.net). Barb worked on the Titan program for 25 years, was on the launch support team for the Cassini launch (and many other Titan launches) and is currently in charge of special studies and analyses for Mission Success Integration at LMSSC. She and her husband Steve also volunteer for JPL as part of the Solar System Ambassador program, a public outreach initiative to help civic and school groups learn about exploration programs; the Cassini mission is one of their favorite topics. Barb's Honda CRV has vanity plates that say "Cassini".

Photo 1: Titan TIVB-33/TC-21 Cassini Launch
Credit: USAF/NASA/JPL

Photo 2: Saturn from the Cassini spacecraft
Photo credit: NASA/JPL/Space Science Institute

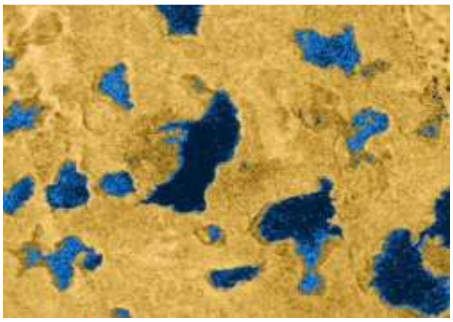

Photo 3: Ethane/Methane lakes on Titan (radar image)
Photo Credit: NASA/JPL

Photo 4: Enceladus venting from its south pole
Photo Credit: NASA/JPL/Space Science Institute