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Astrodynamics



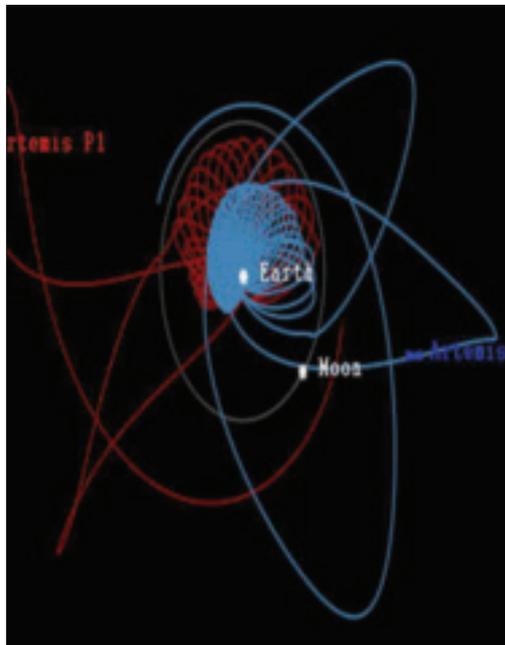
The Hayabusa capsule, which returned to Earth after a seven-year journey to asteroid Itokawa, is seen on the right, leading the debris and disintegration of the spacecraft. Courtesy JAXA/NASA.

In February, a challenging mission to the Moon was cleared for mission implementation. NASA approved sending two of the outer THEMIS (time history of events and macroscale interactions during substorms) probes into lunar orbits to make measurements of the lunar wake, magnetotail, and solar wind through 2012. This new mission is named ARTEMIS (acceleration, reconnection, turbulence, and electrodynamics of Moon interaction with the Sun), and implementation was carried out in collaboration with University of California-Berkeley, JPL, and NASA Goddard. ARTEMIS is the first mission to consider placing an Earth-orbiting constellation into a lunar constellation.

Given the limited resources and scheduling, finding a practically feasible mission design was an extremely challenging task. After a series of orbit-raising maneuvers at Earth, both probes followed low-energy transfer trajectories into Lissajous orbits around Earth-Moon Lagrange points. After lunar orbit insertions, targeted for April 2011, the probes will orbit the Moon for 18 months. This will be followed by controlled crashes of both probes onto the lunar surface.

Also in February, NASA announced the second extension of the international Cassini-Huygens mission to explore the Saturnian system until 2017, the time of summer solstice in Saturn's northern hemisphere. The

ARTEMIS, which will orbit the Moon for 18 months beginning in April 2011, followed a low-energy transfer trajectory. Courtesy UC-Berkeley/NASA Goddard/JPL.



extended-extended mission (XXM), called the Cassini Solstice Mission, enables study of the seasonal and other long-term weather variations. The 155 orbits of the XXM tour are designed to maximize the number of satellite flybys, especially encounters with moons Titan and Enceladus. The final phase of the tour is in many ways similar to the Juno mission at Jupiter, which would provide unique opportunities to investigate the Saturnian magnetosphere and gravity field in depth. In June, the Cassini spacecraft performed the lowest Titan flyby of the entire mission at an altitude of only 880 km.

On April 15, President Obama delivered a major space exploration speech at Kennedy Space Center. A new element of his plan is to launch a human mission to an asteroid by 2025; this would serve as a stepping-stone to a crewed orbital mission to Mars in the mid-2030s, with a landing as a follow-up. Because of this new vision, the astrodynamics aspects of sending and returning crewed missions to near Earth objects are being studied closely by many space organizations.

JAXA launched two missions, Akatsuki and IKAROS (interplanetary kite-craft accelerated by radiation of the Sun), aboard an H-IIA 202 rocket on May 20. The Akatsuki spacecraft, also known as Planet-C, will arrive at Venus this month and will study its atmosphere and surface. IKAROS is a solar sail technology demonstration mission using a 200-m², 0.3-mm-thick polyimide experimental sail. The sail was successfully deployed on June 10, making IKAROS the first fully operating interplanetary solar sail mission. The spacecraft, solely powered by sunlight, is currently on a six-month cruise to Venus.

On June 13, Japan's Hayabusa spacecraft made its glorious return to Earth after a seven-year journey to the asteroid Itokawa. The Hayabusa mission is the first Earth return of a low-thrust spacecraft. On its return trajectory the craft surmounted a number of challenging obstacles and managed to land in the South Australian Outback while the bus broke into pieces and created a spectacular fireball.

Also in the area of small-body exploration, ESA's Rosetta spacecraft successfully flew by asteroid 21-Lutetia, the largest asteroid visited by a spacecraft, at a distance of 3,162 km on July 10. The EPOXI (extrasolar planet observation and deep impact extended investigation) mission encountered its final destination, comet Hartley 2, on November 4. The flyby occurred at a radius of 700 km and comet relative velocity of 12.3 km/sec. 

by Ryan S. Park