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NASA mosaic of
#PlutoTime photos

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After some 2 ½ years of cruise from the Asteroid Vesta, NASA's Dawn spacecraft in March entered an orbit around Ceres, the only dwarf planet in the asteroid belt, and became the first spacecraft to orbit a dwarf planet as well as two distinct solar system bodies. With only two functioning reaction wheels, Dawn has been operating nominally with impressive performance and revealed a number of important discoveries of Ceres, including mysterious bright spots. Dawn will continue its primary science sequences through 2016.

Launched in 2006, NASA's New Horizons spacecraft in July made the first encounter with Pluto, the largest known dwarf planet in the solar system, with the closest approach distance of 12,500 kilometers and speed of 14 km/second. With only a few minutes of window for observing Pluto and its satellites, this flawless flyby revealed amazing surface features, including a 3.5-km icy mountain on Pluto. The spacecraft is now en route to its second target, a **Kuiper belt object** called 2014 MU69, and is expected to arrive at the target in 2019.

After four years of orbiting Mercury, NASA's **Messenger** spacecraft used the last of its remaining propellant to end its mission by impacting the surface of Mercury on April 30.

The European Space Agency's (ESA) Philae lander, which was dropped onto Comet 67P/Churyumov-Gerasimenko from the Rosetta spacecraft in November 2014 with the first soft landing on a comet nucleus, beamed an 85-second wake-up message to Earth via Rosetta on June 13. That communication was the first signal from this solar-powered comet lander in seven months since the probe fell silent shortly after its landing.

After a main engine failure in 2010, the Japan Aerospace Exploration Agency, JAXA, planned another attempt in December with its Akatsuki probe to orbit Venus and explore its atmosphere. The resulting orbit will have a similar periapsis compared to the originally planned science orbit, but will be much more eccentric with about four or five times larger apoapsis.

Japan's **Hayabusa-2 mission**, which launched in December 2014, continues on its way to the target asteroid (162173) 1999JU3. The spacecraft is propelled by its ion engine system and will rendezvous with its target in 2018, collect surface sample, and return it to Earth in 2020. Hayabusa-2's secondary payload, called Proximate

Object Close flyby with Optical Navigation, was scheduled to perform an Earth flyby in December and will head to a to-be-selected target in the main asteroid belt.

A Russian **Soyuz booster rocket** delivered a resupply cargo ship to the International Space Station in July after a string of failed cargo attempts, including a Soyuz launch in April and a Space-X Falcon 9 launch in June.

During planning for the 2020 Asteroid Redirect Mission, NASA in March selected "Option B," which calls for bringing back a boulder from an asteroid to Earth orbit, rather than the whole asteroid as in "Option A."

The eighth **Global Trajectory Optimization Competition**, organized by the Jet Propulsion Laboratory, named as winner a team from ESA and JAXA. The competition's objective is to design trajectories for a simplified Very Long Baseline Interferometry mission using three Earth-orbiting spacecraft with electric propulsion and the option to use lunar gravity assists. The winning solution produced 17 different sources observed and 45 total observations in a flight time of three years.

An exciting year for exploring dwarf planets

by Ryan S. Park

The Astrodynamics Technical Committee advances the science of trajectory determination, prediction, and adjustment, and also spacecraft navigation and attitude determination.



NASA's Dawn spacecraft took this image in June. It shows the bright spots of Occator crater on Ceres from an altitude of 4,400 kilometers. The Occator crater is about 90 kilometers across and 4 kilometers deep.