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2016

YEAR IN REVIEW

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AIAA Shaping the Future of Aerospace

SpaceX

▲ **In April, SpaceX for the first time landed** the first stage of the Falcon 9 on a drone ship.

Launch vehicles get commercial push

BY RYAN S. PARK

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

This was an exciting year for astrodynamics, with an emphasis on commercial space industry that pushed the envelope on launch vehicle and space business capabilities.

Followed by a successful recovery of a reusable **Falcon 9** booster on a landing pad on solid ground in December 2015, SpaceX accomplished an even more challenging success. On April 8, the company launched the two-stage Falcon 9 and delivered a robotic Dragon cargo vehicle carrying crew supplies to the International Space Station for NASA. After separation, the first stage of the Falcon 9 landed back onto a SpaceX drone ship off the Florida coast, marking a huge step toward development of a reusable launch vehicle that may be a paradigm shift for the astrodynamics community.

In April, Rep. Jim Bridenstine, R-Oklahoma, introduced the **American Space Renaissance Act**, which is meant to synergize and reform space enterprises across the United States and ensure U.S. leadership and success across the national space enterprise. The bill motivates a shift of space situational awareness from being a government-led activity to a civil or commercial solution for that function as well as space traffic management.

In August, NASA approved the **Asteroid Redirect Mission**, ARM, to proceed to the next design phase with $1.4 billion in funding. ARM is a two-step mission that will send a robotic spacecraft to bring back a boulder from a near-Earth asteroid, will return it to cislunar orbit and then send astronauts to visit and study the captured object.

Beyond cislunar space, NASA's **Juno** spacecraft rendezvoused with Jupiter in July and set a record as the most distant solar-powered spacecraft ever flown. Juno will be in a 14-day polar orbit around Jupiter with its perijove inside Jupiter's radiation belt, which was carefully designed to be in view from Deep Space Network antenna in Goldstone, California, during perijove passages. Juno will continue to study the structure of Jupiter's interior and atmosphere over its 18-month primary science phase.

In June, NASA approved the plutonium-powered New Horizons spacecraft to fly by the Kuiper Belt Object known as **2014 MU69** in January 2019. This will be the first visit to a Kuiper Belt Object, and to achieve this the New Horizons spacecraft had to conduct a targeting maneuver farther from Earth than any other spacecraft. In late June, Dawn surpassed all of the objectives of its primary mission at dwarf planet Ceres, despite two failed reaction wheels and a very limited supply of hydrazine available for attitude control. The Dawn team received the prestigious 2015 Robert J. Collier Trophy in recognition of the overall success in exploring Vesta and Ceres and the innovative use of ion propulsion.

Europe's **Laser Interferometer Space Antenna** (LISA) **Pathfinder** spacecraft, formerly called Small Missions for Advanced Research in Technology-2, reached the Sun-Earth L1 Lagrange point in January and demonstrated the ability to detect gravitational waves. While several spacecraft have incorporated low-energy orbits in their mission designs, LISA Pathfinder is the first mission to demonstrate low-energy, low-disturbance formation flying between two test masses, technology that enables detection of gravitational waves in space. ★