Innovative use of pressurant extends MESSENGER's mission, enables collection of new data

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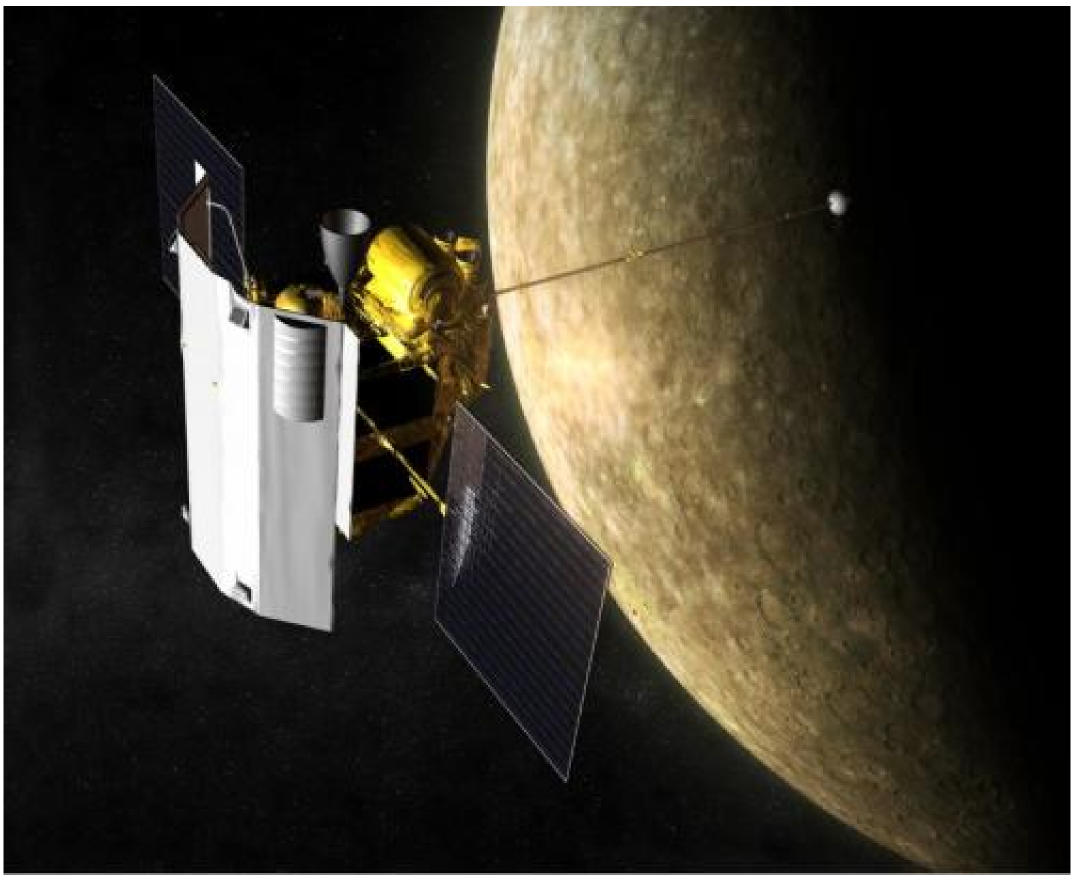

Artist depiction of the MESSENGER spacecraft in orbit around Mercury. Credit: NASA / JHU/APL

The MESSENGER spacecraft will soon run literally on fumes. After more than 10 years traveling in space, nearly four of those orbiting Mercury, the spacecraft has expended most of its propellant and was on course to impact the planet's surface at the end of March 2015. But engineers on the team have devised a way to use the pressurization gas in the spacecraft's propulsion system to propel MESSENGER for as long as another month, allowing scientists to collect even more data about the planet closest to the Sun.

"MESSENGER has used nearly all of the onboard liquid propellant. Typically, when this liquid propellant is completely exhausted, a spacecraft can no longer make adjustments to its trajectory. For MESSENGER, this would have meant that we would no longer have been able to delay the inevitable impact with Mercury's surface," explained MESSENGER Mission Systems Engineer Dan O'Shaughnessy, of the Johns Hopkins University Applied Physics Laboratory, in Laurel, Md. "However, gaseous helium was used to pressurize MESSENGER's propellant tanks, and this gas can be exploited to continue to make small adjustments to the trajectory."

This gas is less efficient, he added, but as effective as the liquid propellant at modifying the spacecraft's trajectory.

"The team continues to find inventive ways to keep MESSENGER going, all while providing an unprecedented vantage point for studying Mercury," said APL's Stewart Bushman, lead propulsion engineer for the mission. "To my knowledge this is the first time that helium pressurant has been intentionally used as a cold-gas propellant through hydrazine thrusters. These engines are not optimized to use pressurized gas as a propellant source. They have flow restrictors and orifices for hydrazine that reduce the feed pressure, hampering performance compared with actual cold-gas engines, which are little more than valves with a nozzle."

"Propellant, though a consumable, is usually not the limiting life factor on a spacecraft, as generally something else goes wrong first," he continued. "As such, we had to become creative with what we had available. Helium, with its low atomic weight, is preferred as a pressurant because it's light, but rarely as a cold gas propellant, because its low mass doesn't get you much bang for your buck."

Adjusting MESSENGER's trajectory will allow scientists to spend extra time exploring Mercury from close range. This past summer, the team launched a low-altitude observation campaign to acquire the highest-resolution images ever obtained of Mercury, enabling scientists to search for volcanic flow fronts, small-scale tectonic features, layering in crater walls, locations of impact melt, and new aspects of hollows—detailed views that are providing a new understanding of Mercury's geological evolution.

"During the additional period of operations, up to four weeks, MESSENGER will measure variations in Mercury's internal magnetic field at shorter horizontal scales than ever before, scales comparable to the anticipated periapsis altitude between 7 km and 15 km above the planetary surface," said APL's Haje Korth, the instrument scientist for the Magnetometer. "Combining these observations with those obtained earlier in the mission at slightly higher altitudes will allow the depths of the sources of these variations to be determined. In addition, observations by MESSENGER's Neutron Spectrometer at the lowest altitudes of the mission will allow water ice deposits to be spatially resolved within individual impact craters at high northern latitudes."

MESSENGER's periapsis altitude is now approximately 101 kilometers and decreasing. The next orbit-correction maneuver on January 21, 2015, will raise the altitude at closest approach from approximately 25 kilometers to just over 80 kilometers.

Provided by NASA