

## NASA's Lunar Reconnaissance Orbiter (LRO) and The Lunar Crater Observation and Sensing Satellite (LCROSS)

On June 18, 2009, NASA launched the [Lunar Reconnaissance Orbiter](#) (LRO) and the [Lunar Crater Observing and Sensing Satellite](#) (LCROSS) aboard an Atlas V 401 rocket. These missions are part of the Lunar Precursor Robotic Program at NASA's Marshall Space Flight Center as the initial steps in the planned human return to the Moon outlined by President George W. Bush in the 2004 Vision for Space Exploration.

On September 17, 2009, NASA [reported](#) that LRO had successfully completed its testing and calibration phase and entered its mapping orbit of the moon. Initial observations suggest that permanently shadowed regions – with extreme temperatures of about minus 400 degrees Fahrenheit (33 Kelvin) – may harbor water and hydrogen. NASA's Goddard Space Flight Center built and manages the mission, with a contribution from the Institute for Space Research in Moscow. The \$540 million orbiter, which will stay in orbit for at least a year 31 miles above the surface, has a payload of six instruments and one technology demonstration and will produce surface, temperature and radiation maps of the moon, as well as scout for safe landing sites and potential resources for human explorers.

LRO's companion mission, LCROSS, had the objective of verifying the existence of water on the Moon and was managed by NASA's Ames Research Center with its spacecraft partner, Northrop Grumman. LCROSS executed a fly-by of the Moon on June 23, 2009. On September 11, 2009, NASA confirmed that the spacecraft had enough fuel to accomplish its mission objectives, a concern that arose after it encountered [problems](#) in August. On October 9, 2009, LCROSS [impacted](#) the [Cabeus](#) crater on the Moon's south pole, four minutes after and several kilometers away from where its Centaur upper stage hit the surface. The impacts created plumes of dust that were measured by instruments aboard the spacecraft, as well as by astronomers using ground-based instruments who participated in the [LCROSS Observation Campaign](#).

On November 13, 2009, a month after explaining the need of more [time](#) to analyze data from the impact, NASA [announced](#) the existence of substantial amounts of water on the Moon. The results are based on observations by a near-infrared spectrometer and an ultraviolet visible spectrometer that measured the wavelengths produced by different compounds in the plume, including hydroxyl signatures resulting from contact between water vapor and sunlight. The discovery answers a question that arose in 1999 when NASA's Lunar Prospector found large amounts of hydrogen at the Moon's South Pole and first suggested the presence of water. Additional observations made by other instruments will shed light on the composition, quantities, and sources of the water, which could, conceptually be excavated by astronauts and used as a resource. A formal presentation is expected at the American Geophysical Union's meeting in December.

The National Research Council's 2007 report, [Scientific Context for Exploration of the Moon](#), provides more information about the scientific importance of the Moon's poles.