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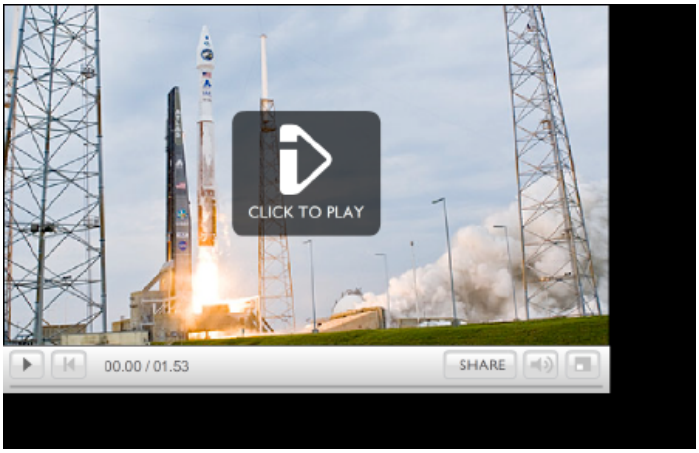
Lift off for Nasa's lunar probes

By Paul Rincon
Science reporter, BBC News



The Atlas V rocket blasts off

Nasa has successfully launched two spacecraft to the Moon on missions that will pave the way for a return to the lunar surface by US astronauts.

LRO (Lunar Reconnaissance Orbiter) and a crater observation mission blasted off from Florida on an Atlas V rocket.

Data gathered by LRO will help mission planners select future landing sites and scout locations for lunar outposts.

The second mission will send a rocket crashing into the Moon to scour the debris plume for evidence of water ice.

The Atlas main launcher, carrying both payloads, roared up from Cape Canaveral Air Force Station at 2232 BST (1732 local time) - the third and last of Thursday's three launch opportunities.

Thunderstorms around the site prevented a launch of the rocket at the original time of 2212 BST (1712 local time).

> **"We did (laser altimetry) for Mars and it revolutionised our understanding of that planet. It's going to do that for the Moon"**
>
> James Head, Brown University

LRO will enter a low polar orbit around the Moon at an altitude of around 50km (31 miles).

It will spend at least one year orbiting the Moon, using its six instruments to collect detailed information about the lunar environment.

"Together with the international armada of missions that have been

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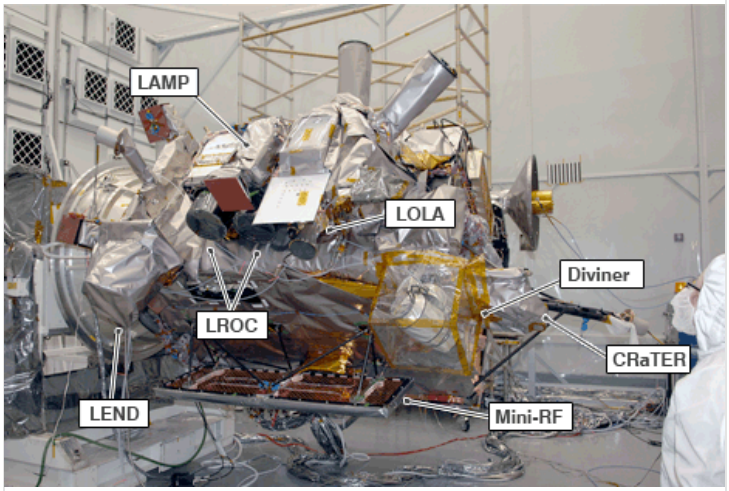
flown lately and are still in orbit, (this mission) will really bring the Moon to a new plateau of understanding," Professor James Head, from Brown University in Rhode Island, US, told BBC News.

Professor Head is a co-investigator on the spacecraft's Lunar Orbiter Laser Altimeter (LOLA) experiment, which will produce an accurate global topographic model for the Moon.

LRO'S SCIENCE INSTRUMENTS



CRaTER - will characterise the global lunar radiation environment
Diviner - is to measure lunar surface temperatures
LAMP - will map the Moon's permanently shadowed regions
LEND - measures the flux of neutrons from the Moon
LOLA - will provide a global lunar topographic model
LROC - LRO's camera will help select future landing sites
Mini-RF - uses radar to search for evidence of water ice

"We did (laser altimetry) for Mars and it revolutionised our understanding of that planet. It's going to do that for the Moon," said Professor Head, who also worked as a scientist on the Apollo missions.

"We don't have very good quantitative topography data for the Moon. This is just going to wallpaper the place with very high resolution data that are going to make us understand the Moon better in ways we just can't comprehend right now. That's just one experiment, so it's very exciting."

New topographic data would provide important information on the thermal structure and thickness of the lunar crust as well as how the crust and the inner lithosphere had changed over time.

It would shed light on the relationship between past volcanic and tectonic activity on the Moon.

In addition to mapping the surface in unprecedented detail, the mission will enhance our understanding of the Moon's mineral composition, global temperatures and lighting conditions.

The mission will also seek to characterise the Moon's radiation environment, helping mission planners assess the risks posed to astronauts.

"The more we learn about the Moon, the better scientific questions we can pose, and the better locations we can find for future lunar landings for robotic and human explorers," said David Paige from the University of California Los Angeles (UCLA), principal investigator for LRO's Diviner science instrument.

Double impact

The second mission, the Lunar Crater Observation and Sensing

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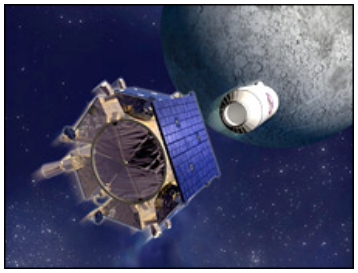
Satellite (LCROSS), aims to answer whether there is water on the Moon - either in the form of ice or hydrated minerals. It consists of two elements: a shepherding spacecraft and a Centaur upper stage rocket.

After being guided to a permanently shadowed crater at the Moon's south pole by its shepherding spacecraft, the Centaur rocket separates.



LCROSS will crash a rocket into the lunar surface

Hitting the Moon at more than 9,000 km/h (5,600 mph), the 2,200kg Centaur will kick up a huge plume of debris which could rise to 50km (30 miles).

It is expected to excavate some 350 metric tonnes of lunar material.

Kimberly Ennico, payload scientist on LCROSS, told BBC News: "The actual crater has not been chosen. There are several candidates for targets and the LCROSS mission will be using late-breaking maps of the lunar south pole by the LRO orbiter to assist in the choice."

Four minutes after the Centaur strikes the lunar surface, the shepherding spacecraft will follow a very similar path to the rocket, descending through the plume.

It will use its instruments to analyse the material, searching for water ice and vapour, hydrocarbons and hydrated materials.

The spacecraft will collect data continuously until it too slams into the lunar surface, creating a second plume.

The impacts will be watched closely by astronomers using ground-based telescopes.

Dr Ennico said the impacts of the Centaur and shepherding spacecraft would generate small craters with diameters of 20m and 14m respectively within a larger natural depression.

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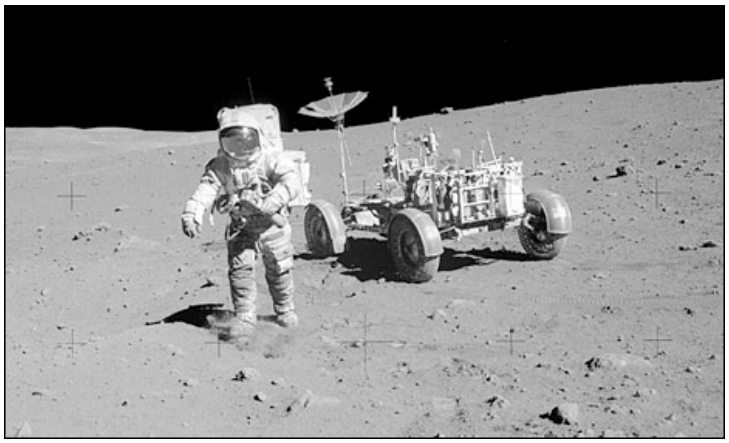
"Meteoroid impacts have similar energies to the LCROSS impacts, occurring naturally two to three times a month. Although they may be smaller - softball to basketball sized - they are travelling much faster than the LCROSS impactors," she explained.

If there are natural reserves of water on the Moon, perhaps concealed in permanently shadowed craters, they are likely to figure prominently in planning for future manned lunar bases.

Water can be split into hydrogen for rocket fuel and oxygen for breathing and it makes an excellent shield against radiation.

"If you take the theory of cometary impacts and migration of water to cold traps, in principle, it sounds plausible," James Head explained.

"But if we don't discover water ice in that context, it's also going to tell us a lot about the lunar conditions."



LRO will carry out an investigation of the Apollo 15 landing site from orbit

Professor Head added that scientists would be combining LRO's science data with those gathered by previous missions, including Apollo.

The orbiter will carry out an investigation of the Apollo 15 landing site at Hadley Rille. Apollo 15's commander Dave Scott has been helping plan the science campaign.

The Brown University researcher said this project would allow scientists to "think about what we have learnt in the lab, what we can learn from the new data about his (Mr Scott's) site and where he went and then to use that as an example of how to return (to the Moon) with sophisticated exploration".

The US space agency hopes to send astronauts back to the Moon by 2020 for the first manned visit since 1972.

However, the Obama administration has ordered a sweeping independent review of Nasa's manned spaceflight strategy, which could potentially set the agency on a different course.

The first public hearing of the Review of US Human Space Flight Plans Committee was held at the Carnegie Institute in Washington DC on Wednesday.

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