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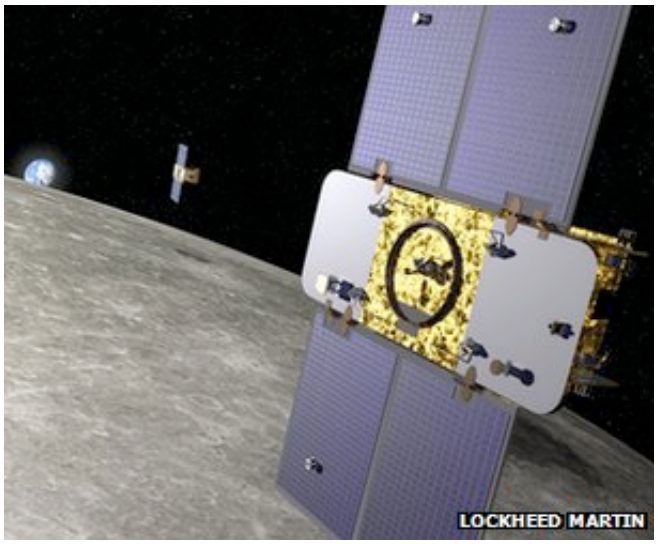
First of Nasa's Grail gravity twins enters Moon orbit

By Jonathan Amos Science correspondent, BBC News



Nasa has succeeded in putting the first of two gravity mapping satellites in orbit around the Moon.

The Grail-A spacecraft fired its main engine late on Saturday (GMT) to slow itself sufficiently to take up an elliptical path around the lunar body.

Its twin, Grail-B, will attempt exactly the same manoeuvre on Sunday.

Together, the satellites will make measurements that are expected to give scientists remarkable new insights into the internal structure of the Moon.

This new data should clarify ideas about the Moon's formation and resolve many questions, such as why its near and far sides look so different.

Lead scientist Dr Maria Zuber is hoping for some dramatic discoveries.

"My resolution for the new year is to unlock lunar mysteries and understand how the Moon, Earth and other rocky planets evolved," the Massachusetts Institute of Technology (MIT) researcher said.

"Now, with Grail-A successfully placed in orbit around the Moon, we are one step closer to achieving that goal."

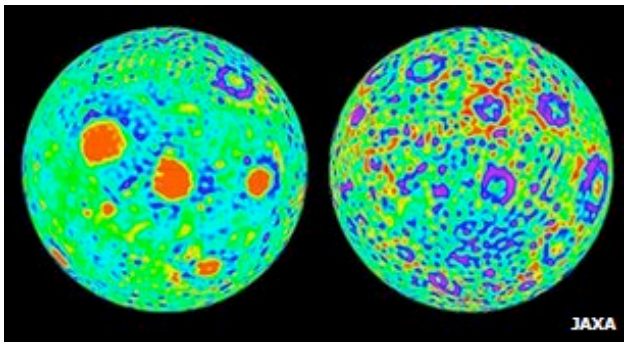
The duo were launched from Cape Canaveral, Florida, last September, and took a long spiral out to their destination.

This weekend's approach to the Moon was designed to bring them in over the south pole.

Grail-A, which is running ahead of its twin, initiated its orbit insertion manoeuvre at 2121 GMT with a 40-minute burn on its 22-newton thruster.

Grail-B is programmed to make an almost identical burn on Sunday, starting at 2205 GMT. Nasa should have confirmation shortly before 2300 GMT on New Year's Day that both satellites are in the positions they should be.

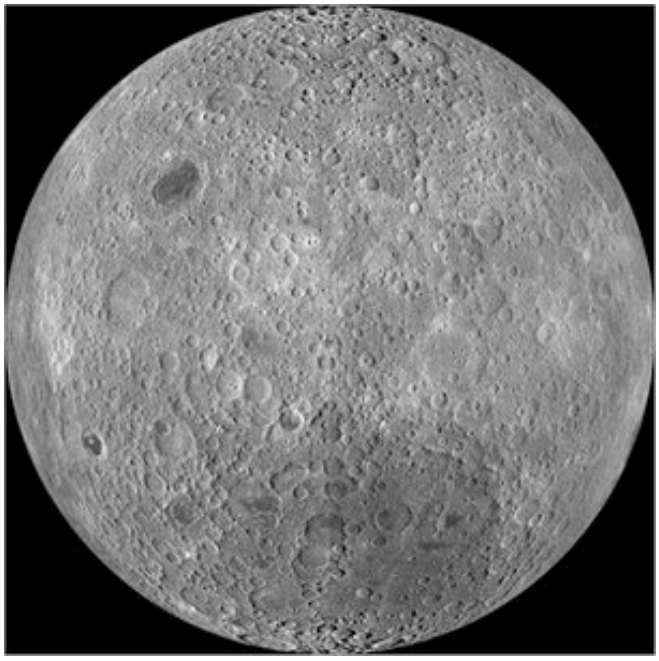
"Following the lunar orbit insertion, the spacecraft will perform a series on intricate burns that take about two months, and these are required to get both spacecraft down to a [55km; 34-mile] altitude; and once that's done, that's when the science for Grail can begin," explained David Lehman, the mission's project manager at the Jet Propulsion Laboratory (JPL) in California.



Existing gravity maps are very coarse compared with what Grail should be able to produce

Grail will map the small variations in gravity across the Moon.

These differences are the result of an uneven distribution of mass. Obvious examples at the Moon's surface include big mountain ranges or deep impact basins, but even inside the lunar body the rock will be arranged in an irregular fashion, with some regions being denser than others.



All this will have a subtle influence on the pull of gravity sensed by over-flying spacecraft.

The Grail twins will make their measurements by carrying out a carefully calibrated pursuit of each other.

As the lead spacecraft flies through the uneven gravity field, it will experience small accelerations or decelerations. The second spacecraft, following some 100-200km behind, will detect these disturbances as very slight changes in the separation between the pair - deviations that are not much more than the width of a human red blood cell.

When the gravity map is combined with comparable-resolution topographical information showing the surface highs and lows, scientists should be able to deduce the Moon's probable internal structure and composition. This is fundamental knowledge that will play into theories of how the lunar body formed and how it has evolved over time.

"We believe the Moon formed from the impact of a Mars-sized object into Earth, but we understand little really of how this happened and how the [lunar body] cooled off after the violent event," said Dr Zuber. And she described as "shocking", the continued inability of science to explain why the rugged far-side of the Moon looks so different from that of the nearside with its great swathe of dark volcanic plains, or maria.

"Given that we've sent so many missions that have studied the outside of the Moon, it seems that the answer is not on the surface. The answer is locked in the interior," she said.

Grail's mapping phase will last for 82 days until early June. The Moon then goes into shadow, into eclipse, behind the Earth.

If the satellites can survive the hours of darkness on their batteries, it is likely they will be tasked with a second mapping cycle in the second half of 2012.

This would be at a much reduced altitude, perhaps as low as 25km from the surface. Getting lower would improve the resolution of the gravity maps yet again, and enable scientists to study even the structure of relatively small, shallow craters.

Grail is an acronym for Gravity Recovery and Internal Laboratory. The satellites will be given more engaging names than just "A" and "B" once the weekend's orbit insertion is confirmed. The names are being chosen via a public competition.

The Grail twins are very compact spacecraft. They each weighed little more than 300kg at launch