

NASA twin spacecraft GRAIL on final approach for moon orbit

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The twin GRAIL spacecraft are prepared for launch. Image credit: NASA/JPL-Caltech/LMSS

(PhysOrg.com) -- NASA's twin spacecraft to study the moon from crust to core are nearing their New Year's Eve and New Year's Day main-engine burns to place the duo in lunar orbit.

Named Gravity Recovery And Interior Laboratory (GRAIL), the spacecraft are scheduled to be placed in orbit beginning at 1:21 p.m. PST (4:21 p.m. EST) for GRAIL-A on Dec. 31, and 2:05 p.m. PST (5:05 p.m. EST) on Jan. 1 for GRAIL-B.

"Our team may not get to partake in a traditional New Year's celebration, but I expect seeing our two spacecraft safely in [lunar orbit](#)

should give us all the excitement and feeling of euphoria anyone in this line of work would ever need," said David Lehman, project manager for GRAIL at NASA's Jet Propulsion Laboratory (JPL) in Pasadena, Calif.



Moon. Image credit: NASA

The distance from Earth to the [moon](#) is approximately 250,000 miles (402,336 kilometers). NASA's Apollo crews took about three days to travel to the moon. Launched from [Cape Canaveral Air Force Station](#) Sept. 10, 2011, the GRAIL spacecraft are taking about 30 times that long and covering more than 2.5 million miles (4 million kilometers) to get there.

This low-energy, long-duration trajectory has given mission planners and controllers more time to assess the spacecraft's health. The path also allowed a vital component of the spacecraft's single [science instrument](#), the Ultra Stable Oscillator, to be continuously powered for several months. This will allow it to reach a stable operating temperature long before it begins making science measurements in lunar orbit.

"This mission will rewrite the textbooks on the evolution of the moon," said Maria Zuber, GRAIL principal investigator from the Massachusetts Institute of Technology (MIT) in Cambridge. "Our two spacecraft are operating so well during their journey that we have performed a full test of our science instrument and confirmed the performance required to meet our science objectives."

As of Dec. 28, GRAIL-A is 65,860 miles (106,000 kilometers) from the moon and closing at a speed of 745 mph (1,200 kph). GRAIL-B is 79,540 miles (128,000 kilometers) from the moon and closing at a speed of 763 mph (1,228 kph).



Artist's concept of lunar interior and exterior. Image credit: NASA

During their final approaches to the moon, both orbiters move toward it from the south, flying nearly over the lunar south pole. The lunar orbit insertion burn for GRAIL-A will take approximately 40 minutes and change the spacecraft's velocity by about 427 mph (688 kph). GRAIL-B's insertion burn 25 hours later will last about 39 minutes and is

expected to change the probe's velocity by 430 mph (691 kph).

The insertion maneuvers will place each orbiter into a near-polar, elliptical orbit with a period of 11.5 hours. Over the following weeks, the GRAIL team will execute a series of burns with each spacecraft to reduce their orbital period from 11.5 hours down to just under two hours. At the start of the science phase in March 2012, the two GRAILs will be in a near-polar, near-circular orbit with an altitude of about 34 miles (55 kilometers).

When science collection begins, the spacecraft will transmit radio signals precisely defining the distance between them as they orbit the moon. As they fly over areas of greater and lesser gravity, caused both by visible features such as mountains and craters and by masses hidden beneath the lunar surface, they will move slightly toward and away from each other. An instrument aboard each [spacecraft](#) will measure the changes in their relative velocity very precisely, and scientists will translate this information into a high-resolution map of the Moon's gravitational field. The data will allow mission scientists to understand what goes on below the surface. This information will increase our knowledge of how Earth and its rocky neighbors in the inner solar system developed into the diverse worlds we see today.

Provided by JPL/NASA

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