PROSPECTS FOR UNDERSTANDING THE INTERNAL STRUCTURE AND THERMAL EVOLUTION OF THE MOON: STATUS AND PLANS FOR THE GRAVITY RECOVERY AND INTERIOR LABORATORY (GRAIL) MISSION. M. T. Zuber[1], D. E. Smith[1], D. H. Lehman[2], M. M. Watkins[2], and the GRAIL Team. [1]Department of Earth, Atmospheric & Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA 02139-4307, (zuber@mit.edu); [2]Jet Propulsion Laboratory, Pasadena, CA. 91109-8099.

Introduction: The structure of the lunar interior (and by inference the nature and timing of compositional differentiation and of internal dynamics) holds the key to reconstructing the thermal evolution of the Moon. Longstanding questions such the origin of the maria, the reason for the nearside-farside asymmetry in crustal thickness, and the explanation for the puzzling magnetization of crustal rocks, all require a greatly improved understanding of the Moon's interior. Knowledge of the interior and evolution of the Moon, and by extension, other terrestrial planets, will be greatly advanced by the Gravity Recovery And Interior Laboratory (GRAIL) mission. GRAIL has completed its System Integration Review, and the dual spacecraft are currently being assembled in anticipation of a September 2011 launch.

The GRAIL Mission: GRAIL is the lunar analog of the very successful GRACE [1] twin-spacecraft terrestrial gravity recovery mission that continues to operate. GRAIL will be implemented with a science payload derived from GRACE and a spacecraft derived from the Lockheed Martin Experimental Small Satellite-11 (XSS-11), launched in 2005.

GRAIL has two primary objectives: to determine the structure of the lunar interior, from crust to core; and to advance understanding of the thermal evolution of the Moon. These objectives will be accomplished by implementing the following lunar science investigations:

- Map the structure of the crust & lithosphere.
- Understand the Moon's asymmetric thermal evolution.
- Determine the subsurface structure of impact basins and the origin of mascons.
- Ascertain the temporal evolution of crustal brecciation and magmatism.
- Constrain deep interior structure from tides.
- Place limits on the size of the possible inner core.

In addition, as a secondary objective, GRAIL observations will be used to extend knowledge gained on the internal structure and thermal evolution of the Moon to other terrestrial planets.

GRAIL will place two twin spacecraft in a low-altitude (50 km), near-circular, polar lunar orbit to perform high-precision range-rate measurements between them using a Ka-band payload. Subsequent data analysis of the spacecraft-to-spacecraft range-rate data will provide a direct measure of the lunar gravity, that will lead to a high-resolution (30x30 km), high-accuracy (<10 mGal) global gravity field.

The payload, flight system and mission design ensure that all error sources that perturb the gravity measurements are contained at levels well below those necessary to meet science requirements.

GRAIL's total mission duration (270-days) includes a planned launch in September of 2011, followed by a low-energy trans-lunar cruise for the dual-spacecraft check-out and out-gassing, and a 90-day gravity mapping Science Phase. Initial science products will be available beginning 30 days after the start of the Science Phase and will be delivered to NASA's Planetary Data System (PDS) no later than 3 months after the end of the Science Phase.

The GRAIL mission team completed its System Integration Review in June 21-24, 2010 and spacecraft assembly is underway (Figure 1) at Lockheed Martin Space Systems in Denver, CO. The mission's single science instrument, the Lunar Gravity Ranging System, designed and assembled at the Jet Propulsion Laboratory in Pasadena, CA, is nearly complete and anticipating on-time delivery for spacecraft integration.

References: [1] Tapley B. D. (2004) *Science, 305,* doi: 10.1126/science.1099192.

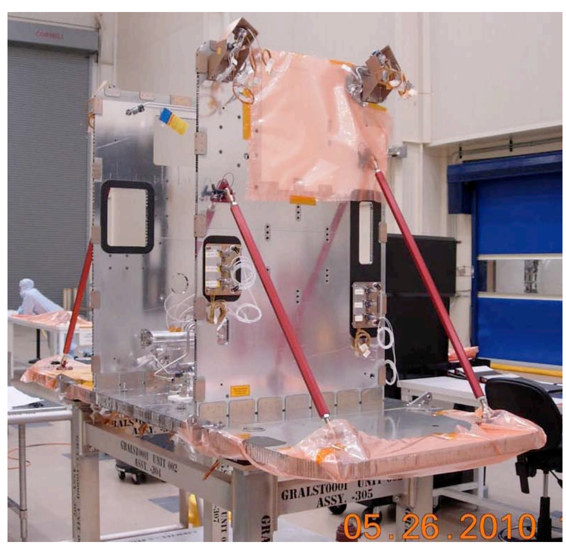

Figure 1. GRAIL spacecraft assesmbly at Lockheed Martin Space Systems, Denver.