THE LUNAR RECONNAISSANCE ORBITER: PLANS FOR THE SCIENCE PHASE. R. R. Vondrak[1], J. W. Keller[1], G. Chin[1], J. Garvin[1], J. Rice[1], N. Petro[1], and M. Mesarch[1], [1]Goddard Space Flight Center, Greenbelt MD 20771.

Introduction: The Lunar Reconnaissance Orbiter spacecraft (LRO), which was launched on June 18, 2009, began with the goal of seeking safe landing sites for future robotic missions or the return of humans to the Moon as part of NASA's Exploration Systems Mission Directorate (ESMD). In addition, LRO's primary objectives included the search for resources and to investigate the Lunar radiation environment. This phase of the mission was completed on September 15, 2010 when the operational responsibility for LRO was transferred from ESMD to NASA's Science Mission directorate (SMD). Under SMD, the mission focuses on a new set of goals related to the history of the Moon, its current state and what its history can tell us about the evolution of the Solar System.

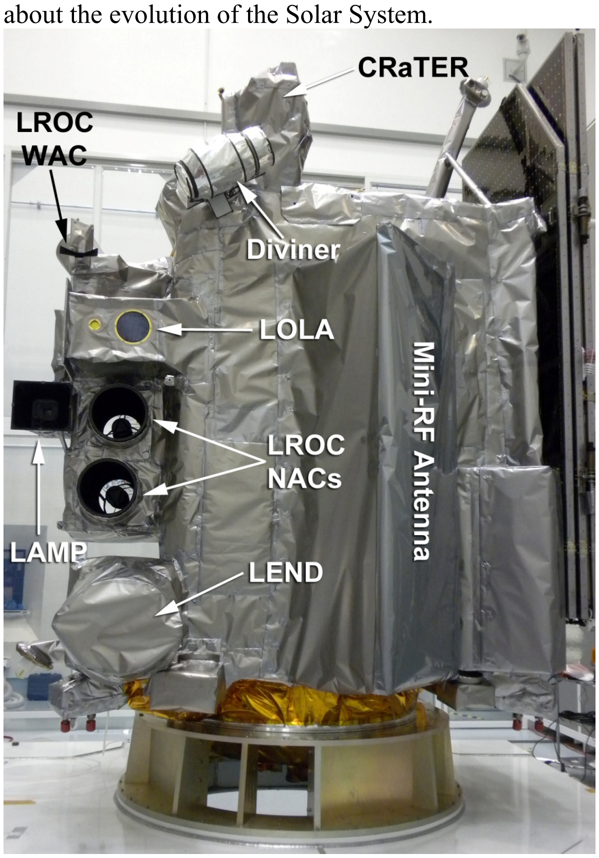

Figure 1 The fully assembled and thermal blanketed spacecraft.

Each of the instruments remain in good operating condition with no major issues. The instruments, which were describe in detail previously[1], include ***Lunar Orbiter Laser Altimeter (LOLA)***, PI, David Smith, NASA Goddard Space Flight Center, Greenbelt, MD, ***Lunar Reconnaissance Orbiter Camera (LROC),*** PI, Mark Robinson, Arizona State University, Tempe, Arizona, ***Lunar Exploration Neutron Detector (LEND)***, PI, Igor Mitrofanov, Institute for Space Research, and Federal Space Agency, Moscow, ***Diviner Lunar Radiometer Experiment (DLRE),*** PI, David Paige, University of California, Los Angeles, ***Lyman-Alpha Mapping Project (LAMP)***, PI, Alan Stern, Southwest Research Institute, Boulder, Colorado, ***Cosmic Ray Telescope for the Effects of Radiation (CRaTER)***, PI, Harlan Spence, University of New Hampshire, New Hampshire, and ***Mini Radio-Frequency Technology Demonstration (Mini-RF)***, P.I. Ben Bussey, Applied Physics Laboratory, Maryland.

Mission Objectives: The LRO Science Mission (SM) project focuses on the cost-effective utilization of LRO and its measurement payload to address the broadest suite of NRC Lunar science priorities as specified in the 2007 *Scientific Context for the Exploration of the Moon* report developed by the NRC, as well as the 2003 NRC *Solar System Decadal Survey [New Frontier in the Solar System, 2002]*. The seven LRO flight experiments will be operated for two years to produce scientific data that address several specific objectives. The primary science objectives of the LRO Science Mission project are to:

1. Investigate the bombardment history of the Moon, including basin-forming events and modern impact processes, via detailed center-of-mass-referenced topography, surficial mineralogy, and regional imaging at process scales
2. Investigate Lunar geologic processes and their role in the evolution of the Lunar crust and shallow lithosphere using geodetic (center-of-mass referenced) topography, high resolution imaging, mineralogical mapping, and relevant derived datasets
3. Investigate the processes that have shaped the global Lunar regolith by means of microwave scattering properties, thermal inertia properties, local geologic processes, as well as small-scale roughness and local-scale topography/slopes
4. Investigate and quantify the types, sources, sinks, and transfer mechanisms associated with volatiles on the Moon with emphasis on the polar regions using collimated neutron spectroscopy, high resolution geodetic topography, surface temperatures and their seasonal variations, regional imaging to identify the geologic context, and the ultraviolet signatures of ephemeral Lunar atmospheric/surface species (i.e., transport of atmospheric species across the Lunar surface)

5. Investigate how the space environment interacts with the Lunar surface on diurnal, seasonal, and yearly time scales via direct measurements of the ephemeral Lunar atmosphere, the character of space radiation and other properties

Orbit Options: The LRO spacecraft is currently in its designed mapping orbit (MO) of 50 ± 15 km altitude, nearly circular polar orbit about the Moon. However this orbit cannot be sustained indefinitely since it is inherently unstable and requires that it be reset periodically at the expense of diminishing propellant reserves. We have explored several options for the extended mission. Each option concludes with a highly stable frozen orbit that will allow the mission to proceed for an indefinite period of time. The Frozen Orbit (FO) is elliptical, with an approximately 30 x 216 km periapsis and apoapsis, with periapsis fixed over the South Pole. In addition to potentially staying in the mapping orbit, we have considered a class of elliptical transition orbits that begin with periapsis near the equator and which evolve over time to become more circular while the periapsis migrates over the North Pole (Figure 2). The cycle completes as periapsis continues to migrate toward the equator and the orbit proceeds toward the original ellipicity. The advantage of these orbits is that they provide low altitude coverage at low latitudes and over the North Pole for an extended period beyond what is achievable in the MO. At the end of the cycle, the orbit will be moved to the FO or, providing sufficient propellant, it will be reset for a second cycle of the transition orbit.

Operations: The LRO spacecraft is primarily a nadir mapper and during the ESMD phase of the mission spent 96% of the time viewing in the nadir direction or with less than 20 degree slews for geometric stereo imagery. Although the essential character of a nadir mapping orbiter will not change, during the SMD mission more off nadir measurements will be made. These will focus on limb viewing observations by the LAMP UV spectrometer of the Lunar exosphere, and lofted dust particles and high resolution oblique imagery by LROC to provide aditional insight into the perspective of the topography and geomorphology of the moon.

Data Access: All of the LRO data are added to the Planetary Data System on three month intervals, with no data or data products older than 6 months. As of Dec. 15 2010 more than 150 TBytes of data have been made available to the science community.

References: [1] Vondrak, R.R., Keller, J.W., and Russell, C.T., (Ed.s), 2010, Lunar Reconnaissance Orbiter Mission, New York, Springer.

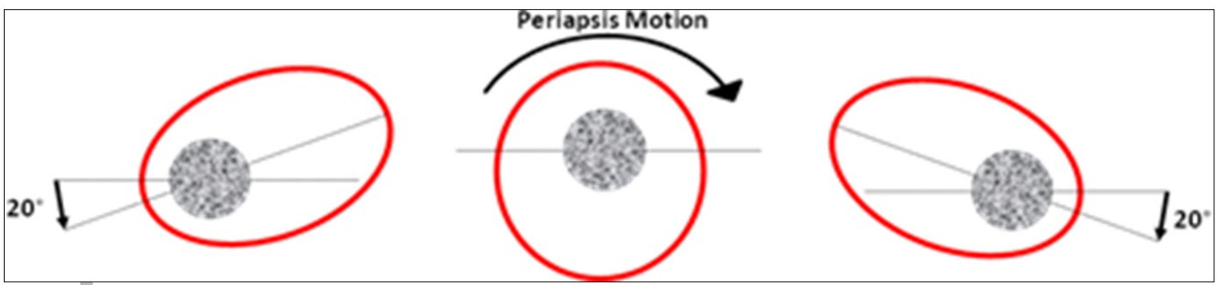

Figure 2 Depicting the evolution of the orbit periapsis through a single cycle of the transition orbit.