C.25 LUNAR RECONNAISSANCE ORBITER (LRO) PARTICIPATING SCIENTISTS

1. Description of the Opportunity

This program element solicits proposals for Lunar Reconnaissance Orbiter (LRO) Participating Scientists (PSs). LRO PSs will serve as members of the LRO Science Team and will participate in LRO Science Team activities such as data analysis, archiving, and publication.

1.1 The LRO Mission

One of the first key milestones in accomplishing the goals of the Vision for Space Exploration, the robotic Lunar Reconnaissance Orbiter (LRO) mission will enable future human exploration and provide excellent opportunities for future science missions. LRO will spend at least one year in low polar orbit around the Moon collecting detailed information about the lunar environment. The LRO payload comprises six instruments and one technology demonstration and will provide key data sets to enable a human to return to the Moon. LRO's instrument suite will provide the highest resolution data and the most comprehensive data set ever returned from the Moon. The scientific objectives of LRO are to:

- Supply information on lunar radiation environment;
- Evaluate the biological impacts of and to humans, and allow the development of protective technologies;
- Provide the first highly accurate 3D lunar cartographic maps
- Map mineralogy across the whole Moon;
- Search for polar volatiles (especially water ice);
- Provide submeter resolution imaging (including permanently shadowed regions); and
- Provide an assessment of features for landing sites.

The mission is currently working toward an October 2008 launch, which will be followed by a 5 day transit to the Moon and a 2 month check out period before beginning one year of prime operations designed to meet the requirements of NASA's Exploration Program. A detailed description of the LRO mission, spacecraft, and instruments can be found at http://lunar.gsfc.nasa.gov/.

1.2 LRO Science Team Activities

During the first year of its mission, LRO will conduct an exploration mission and take measurements from its 50 km circular polar mapping orbit. NASA plans to utilize the LRO spacecraft for a science mission following the completion of the one year exploration mission. Depending on the orbit chosen, the science mission could last from 6 months to 3 years.

For this LRO Participating Scientists program, NASA is soliciting science investigations using the LRO spacecraft during the exploration mission as well as during the science mission following the completion of the exploration mission. Any proposed investigation for the science mission must include the details of the orbit required and must identify the instrument or instruments required, pointing requirements, and must establish that the instrument or instruments, together with the proposed orbit, will provide measurements suitable to address the goals of the proposed scientific investigation.

The LRO Science Team is organized around its instruments, performing the following investigations:

1. Cosmic Ray Telescope for the Effects of Radiation (CRaTER) – to characterize, in the lunar environment, the biological consequences of galactic cosmic rays and solar energetic particles. (http://crater.bu.edu);

2. Lunar Radiometer Experiment (DIVINER) - to map the temperature of the lunar surface at 300 meter horizontal scales. (http://www.moon.ucla.edu);

3. Lyman-Alpha Mapping Project (LAMP) - to obtain maps of the surface reflectance in the permanently shadowed polar regions of the Moon and to map and determine the concentration of water ice in any exposed deposits of ice near the surface in the cold polar areas. (http://www.boulder.swri.edu/lamp/goals.html);

4. Lunar Exploration Neutron Detector (LEND) - to create high resolution hydrogen distribution maps with sensitivity of about 100 ppm and spatial resolution of 5 km, to characterize surface distribution and column density of possible near-surface water ice deposits in the Moon's polar cold traps, and to create a global model of the neutron component of space radiation. (http://lunar.gsfc.nasa.gov/lend.html);

5. Lunar Orbiter Laser Altimeter (LOLA) - to provide a precise global lunar topographic model and geodetic grid, enabling precise targeting, safe landing, and surface mobility, and to characterize the polar illumination environment by imaging permanently shadowed polar regions of the Moon (http://lunar.gsfc.nasa.gov/lola.html);

6. Lunar Reconnaissance Orbiter Camera (LROC) - to acquire images to assess <1 m scale features to facilitate safety analysis for potential lunar landing sites and to identify regions of permanent shadow and illumination (http://cps.earth.northwestern.edu/LROC); and

7. Mini Radio-Frequency Technology Demonstration (Mini-RF) - technical demonstration in the lunar environment of a unique miniaturized multimode radar observatory. The Mini-RF will test the application of the technologies and the integrated multifunctional system for future communications payload utility. In

addition, its synthetic aperture radar (SAR) imaging modes are most relevant to the scientific and exploratory roles of LRO. An earlier application of this technology development, Mini-SAR, a payload on the Chandrayaan-1 Mission, will map the scattering properties of the permanently dark lunar polar regions, including large areas that are never visible from the Earth. The objective of the Mini-SAR is to determine the location and distribution of potential water ice deposits. The Point of Contact for more information about the Mini-RF is Bill Marinelli, Project Manager, at 760-939-4593, or marinellitcs@aol.com.

Although the main focus of the LRO Participating Scientists program is the science mission set to follow the exploration mission, proposals will also be accepted for scientific investigations that develop new data products from exploration mission observations whose rapid development will materially aid the scientific exploitation of the LRO data sets. It should be noted that NASA expects to offer opportunities to analyze all data obtained from LRO through a separate data analysis program for LRO data. Thus, this opportunity within the LRO Participating Scientists program is only for those scientific investigations based on LRO data that produce results and new data products crucial to the rapid exploitation of the LRO data by the scientific community.

2. Role of Participating Scientists and Scientific Scope

LRO PSs will join the existing LRO Science Team members and will participate as full members of the science team. NASA seeks to select PSs in advance to allow ample time for them to familiarize themselves with the details of the mission and observe mission operations from the beginning of the exploration mission. The selected PSs will coordinate their activities and analyses with the LRO Mission Project Scientist, Instrument Principal Investigators, Co-Investigators (Co-Is), and NASA Program Scientist, and they will be bound by team agreements.

The proposed investigations may be analytical, observational, or theoretical in nature. Investigations may involve preparation for orbit change or operations changes, participation in the observing program, and/or follow-up investigations. Proposals should include investigations that:

- Are directly related to the detection, characterization, or understanding of the Moon, the Earth-Moon system, or the origin and evolution of the Solar System;
- Provide added value to the science investigations currently planned by the LRO Science Team; and
- Complement, but are not redundant with, investigations planned or currently in progress by current Science Team members as listed in Section 1.2 above.

For example, the CRaTER measurement goal is to acquire LET spectra in the lunar environment in order to characterize the Moon's radiation environment. Spectra are measured at six points within the CRaTER instrument, behind different amounts and types of areal density, including tissue-equivalent plastic. The CRaTER science goal is ultimately to use these measurements to test models of radiation effects by verifying of

validating model predictions of the LET spectra from parent GCR spectra, particularly those predictions made by the HETC-HEDS model. The CRaTER science team has the HETC-HEDS modeling component in place, however, there is a much larger modeling community beyond the team. Therefore, it is deemed highly advantageous to have modelers using or developing other radiation transport codes. Bringing in the broader modeling community would immediately enhance the CRaTER Level 4 data products that LRO will produce. That will have fundamental scientific value, as well as value to exploration goals. Modelers with specific ties to not just radiation transfer, but also how that radiation transfer converts into biological effects in humans, would be especially desired. Such expertise exists in the U.S. and adding them to our team would be outstanding. Additional examples of appropriate programs include, but are not limited to:

- Detailed study of physical properties of polar cold traps -- definition of potential polar spots with water ice deposits for LEND or other instrument investigations: boundaries, surface relief, temperature, and age;
- Physics of hydrogen implantation and diffusion in lunar regolith: models testing by LEND or other instrument data;
- Neutron component of Lunar radiation environment: from orbital data to surface;
- Validation of Diviner rock abundance results by comparing them with automated or manual rock abundance determinations from the LROC high-resolution images;
- Coordination of observations of the LCROSS crash site with LRO instrument results; and
- Cross-correlation of LRO instrument data.

3. Programmatic Information

3.1 Period of Performance and Availability of Funds

Proposed investigations should specify the period of time of the investigation, for example, whether investigations will be carried out during the exploration mission, the science mission, or both phases of the mission. Participation in only the science mission is acceptable, but science mission proposals should include modest support starting in July 2008 through the end of the exploration mission in January 2010. This will allow the participating scientists to participate in the exploration mission to a sufficient degree to insure a smooth transition to the follow-on science mission. Normally, the level of support should be modest and limited to the principal investigator. Successful proposers will be assigned to one of the instrument teams for the period of the exploration mission.

Proposers for scientific investigations that develop new data products whose rapid development will materially aid the scientific exploitation of the LRO data sets within the exploration mission may budget starting from April 2008 through the end of the prime exploration mission plus one additional year of data analysis and data archiving. It is expected that the budget for each investigation will include support for the principal investigator and at most a graduate student or postdoctoral position.

This is not a solicitation for investigations requiring large teams.

General proposal requirements are given in the *Summary of Solicitation* for this NRA, as well as the *NASA Guidebook for Proposers*. In addition to these general requirements, proposers for the science mission should propose a budget for their participation in the science mission based on the nature of the investigation proposed. The proposer should identify the orbit required and the instrument or instruments to be used to obtain required data sets. Proposers should not budget for the costs of operation of the spacecraft or of the instruments required. NASA will determine these costs based on the information provided by the investigator. The investigator should provide a budget for all other aspects of his or her investigation.

3.2 Evaluation Criteria

Evaluation criteria are given in Appendix C of the *NASA Guidebook for Proposers*. These criteria are intrinsic merit, relevance, and cost realism/reasonableness.

For those who propose to the opportunity to work as LRO Participating Scientists during the exploration mission, in addition to the factors for each criterion given in the *NASA Guidebook for Proposers*, the criterion for intrinsic merit specifically includes the following factors:

- The extent that the scientific investigation proposed develops new data products whose rapid development will materially aid the rapid scientific exploitation of the LRO data sets; and
- The extent that the proposed investigation complements the existing plans of the relevant instrument teams (and does not duplicate existing planned efforts).

For those who propose to the opportunity to work as LRO Participating Scientists during the science mission, in addition to the factors for each criterion given in the *NASA Guidebook for Proposers*, the criterion for intrinsic merit specifically includes the following factors:

- The ability of the spacecraft to achieve and maintain the orbit required for the proposed investigation; and
- The ability of the instruments to obtain the measurements required by the proposed investigation.

For all proposals, in addition to the factors for each criterion given in the *NASA Guidebook for Proposers*, the criterion for intrinsic merit specifically includes the following factors:

- The ability of the spacecraft including operations to meet the requirements of the proposed investigation; and
- The ability of the instruments in the proposed orbit to meet the requirements of the proposed investigation.

3.3 Details of the Evaluation and Selection

Proposals will be reviewed against the criteria and factors given in Appendix C of the *NASA Guidebook for Proposers* and In Section 3.3. There will be a nonadvocate peer review to access the strengths and weaknesses of the proposed investigation with respect to the criteria laid out in the *NASA Guidebook for Proposers* and in Section 3.2 above.

The selection of proposals for the science mission necessarily involves the selection of the orbit and operations for the science mission. Therefore with respect to investigations proposed for the science mission, the selecting official will consider the entire body of proposed investigations for the science mission and select the best investigation or suite of investigations to maximize science return.

Selection of LRO Participating Scientists investigations is the responsibility of the Planetary Sciences Division, Science Mission Directorate, NASA Headquarters. NASA Headquarters will be responsible for the evaluation and selection process associated with this solicitation.

3.4 Eligibility

Application to the LRO PSs program is open to all investigators. Existing LRO Science Team members who wish to submit a proposal in response to this solicitation must provide a compelling justification for the request of additional funds under the LRO PS program and must clearly state how the proposed research is distinct from their funded LRO Science Team activities.

3.5 Guidelines for Non-U.S. Proposals

NASA welcomes proposals from outside the U.S., but generally on a no-exchange-of funds basis. All proposals from non-U.S. participants must be compliant with the policies stated in the *NASA Guidebook for Proposers* (see Section 1.6), including the requirement that they must be endorsed by the respective government agency or funding/sponsoring institution for the entire period of performance of the proposed investigation.

3.6 Awards

LRO PS proposal selections will be funded as three-year awards, with an additional three years possible if a successor proposal is selected in the second LRO PS competition.

The LRO Science team is managed by the LRO Mission Project Scientist at NASA’s Goddard Space Flight Center (GSFC). It is the GSFC LRO Project's responsibility to provide the science interface to the investigation teams.

4. Summary of Key Information

Expected annual program budget for new awards	~ $2 M
Number of new awards pending adequate proposals of merit	~ 15
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	July 16, 2007
Due date for proposals	September 7, 2007
NASA strategic objective(s) which proposals must state and demonstrate relevance to	Every proposal must address one or more strategic goal(s) or strategic outcome(s) from Table 1. See also Sections I(a) and IV(e) in the *Summary of Solicitation* of this NRA.
General information and overview of this solicitation	See the *Summary of Solicitation* of this NRA.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers Responding to a NASA Research Announcement – 2007* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Submission medium	Electronic proposal submission is required; no hard copy is required. See also Section IV in the *Summary of Solicitation* of this NRA and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH07ZDA001N-LROPS
NASA point of contact concerning this program	Dr. Kelly Snook Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-2302 E-mail: Kelly.Snook@nasa.gov