SCIENCE OF AND ON THE MOON WITH THE LUNAR UNIVERSITY NETWORK FOR ASTROPHYSICS RESEARCH. J. Burns[1,3] and J. Lazio[2,3], [1]University of Colorado at Boulder, CASA, 593 UCB, Boulder, CO 80309-0593, USA, [2]Jet Propulsion Laboratory, California Institute of Technology, M/S 138-308, 4800 Oak Grove Dr, Pasadena, CA 91107, USA, [3]NASA Lunar Science Institute.

The Lunar University Network for Astrophysics Research (LUNAR) undertakes investigations across the full spectrum of the science within the mission of the NASA Lunar Science Institute (NLSI), namely science of, on, and from the Moon. The LUNAR team's work on science of and on the Moon is conducted in the broader context of ascertaining the content, origin, and evolution of the solar system. Here we describe the science motivation for instrument packages for a number of future missions.

The **interior structure and composition** of the Moon, particularly of its core, remains poorly constrained. In turn, the size and state of the core (fluid vs. solid) reflect processes that occurred at the time of the formation of the Earth-Moon system, including the likely giant impact responsible for the formation of the Moon, and advancing the state of knowledge of the interior structure was recognized as an important science objective in the *Visions and Voyages for Planetary Science in the Decade 2013–2023* Decadal Survey. Lunar laser ranging provides precision measurements of the Earth-Moon distance at the 10 mm level, and the LUNAR team is developing the technology to advance the precision to the 10 μm level using a next-generation of laser retroreflectors. These retroreflectors could be science packages for a number of future NASA and commercial missions. At these levels of precision, variations in the Moon's librations are easily detectable, and, even at the current 10 mm precision level, using retroreflectors emplaced during the Apollo missions, lunar laser ranging constrains the size of the core to be approximately 400 km in radius, with the specific value depending upon the composition of the core. Other work being undertaken tracks the influence of tides, heat dissipation, and the orbital evolution of the Earth-Moon system.

The **lunar atmosphere** is the exemplar and nearest case of a surface boundary exosphere for an airless body in the solar system. The *Visions and Voyages for Planetary Science in the Decade 2013–2023* Decadal Survey noted that understanding the evolution of exospheres, and particularly their interaction with the space environment, remains both poorly constrained and requires observations at a variety of different bodies. Determining and tracking the properties of the lunar atmosphere both robustly and over time requires a lunar-based methodology by which the atmosphere can be monitored over multiple day-night cycles from a fixed location(s). Relative ionospheric opacity measurements or riometry, measures the amount of power received at different radio frequencies and directly determines the density of the (ionized) atmosphere. The LUNAR team has been developing the technology for a future lunar-based radio telescope, which is also applicable to a lunar riometer that could be deployed on a future lander, either flown by NASA or a commercial entity (e.g., Google X Prize competitor).

The interplanetary medium is pervaded by **dust** from a variety of sources, including small bodies, the inner planets, and interstellar space. Recent work on interplanetary dust by members of the LUNAR team has revealed a substantial population of nanometer size dust, or nanodust, with fluxes hundreds of thousands of times higher than the better understood micron-sized dust grains. This nanodust tends to move with the speed of the solar wind, or at hundreds of kilometers per second, as opposed to more typical Keplerian speeds of tens of kilometers per second. Since impact damage grows faster than the square of the impact speed for high speed dust, nanodust could be an important and previously unrecognized contributor to space weathering. The same technology for a future lunar-based radio telescope would also be applicable for measuring the distribution of dust particles as a function of size in interplanetary space, and ultimately for understanding how dust modifies the surfaces of planets and other objects in the solar system.

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