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Summary: Scientific knowledge of the structure and composition of the lunar interior may be greatly advanced with a network of small, long-lived (> 6 yrs) robotic geophysical probes, globally deployed at strategic locations on the surface of the Moon. Similarly, much can be learned about dynamic plasmas and the exosphere from the lunar surface, akin to lunar weather, through long term globally distributed measurements. Together, these investigations can help characterize the overall lunar environment, by measuring both seismic activity and the changing space environment. In addition to the wealth of scientific information they would provide, these precursor measurements would be invaluable for understanding phenomena that could potentially pose hazards to human exploration, settlement and commercial development. Thus, these investigations directly address two fundamental questions of the LEAG: *(2-4) What are the needs and advantages of robotic missions for advancing lunar science and how can they benefit human exploration? (3-3) What types of precursor lunar surface experiments are highest priority for space settlement and commercial development?*

Seismology: The Lunar interior serves as a time capsule providing clues to its initial composition, differentiation, crustal formation and possible ancient magnetic dynamo. The best, and in some cases the only way to determine the composition and structure of the deep crust, mantle and core is to conduct geophysical measurements [1]. The NRC report, *The Scientific Context for Exploration of the Moon – Interim Report*, finds that "Long-duration geophysical stations … implemented at multiple (six or more) sites are required to provide comprehensive subsurface information" [2].

Shallow moonquakes are the largest of the lunar seismic events. The Apollo missions recorded 28 events, with seven of them greater than a [Richter] magnitude of 5 [3-6]. While they appear to be associated with boundaries between dissimilar surface features [6], the exact origin of shallow moonquakes is still unclear. Strong moonquakes may pose a potential hazard to lunar exploration as well as any permanent lunar habitat or science installations. Thus, the investigation of shallow moonquakes is not only important for understanding basic scientific questions, but also has direct relevance to supporting exploration initiatives.

Exosphere: The existence of a lunar atmosphere was long suspected but unproven until the first Apollo measurements. The Moon is a solid body immersed in the space environment, consisting of incoming solar plasma and illumination, solar energetic particles (SEP) from solar coronal mass ejections (CME), terrestrial plasma in the Earth's geomagnetic tail, and meteoric influx. Given all of these environmental forces acting on the lunar surface, there should exist a host of sputtered materials around the Moon. However, the details of the composition, distribution, and temporal variability of the lunar exosphere are still largely unknown; *in-situ* observations from a contamination-free platform are essential in order to answer these fundamental questions.

These environmental forces also create various electrical currents at the surface of the moon. One consequence of this is the possibility that individual dust grains may become highly charged and be repelled upwards by the equally charged lunar surface. This could explain Lunar Horizon Glow (LHG), first detected by Surveyor. Correlation of these measurements with the terminator strongly suggests that variations in the lunar surface potential and the electrical charging of individual dust grains are key factors in the physical mechanisms producing dust motion.

Dust transport, be it through human or robotic activity, or a natural occurrence, poses a significant problem and possible hazard for both human exploration and commercial development. Beyond the suspicion that dust is lofted above the surface, however, very little is known about the mechanisms or properties of the lofted dust. Such a phenomenon, once characterized, would constitute the discovery of lunar "dust storms", and demonstrate how dust is transported and entrained around and on the lunar surface. This knowledge would be of great utility for both human exploration and scientific understanding.

References: **[1]** *The Scientific Context for Exploration of the Moon: Final Report, N.R.C.*, 2007. **[2]** *The Scientific Context for Exploration of the Moon: Interim Report, N.R.C.*, 2006. **[3]** Oberst J. & Nakamura Y., *Lunar Bases & Space Activities* **2**, 231-233, Lunar & Planetary Institute, Houston, 1992. **[4]** Nakamura Y., et al., *Proc. Lunar Planet. Sci. Conf.* **10th**, 2299-2309, 1979. **[5]** Nakamura Y., *Proc. Lunar Planet. Sci. Conf.* **11th**, 1847-1853, 1980. **[6]** Oberst J., *J. Geophys. Res.* **92**, 1397-1405, 1987.