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**Introduction:** Dust is a major risk management factor for lunar exploration by humans and robots. Knowledge of exospheric dust lifetimes, particle size, and cloud density is critical to develop methodologies and tools to manage and mitigate dust movement and transient environments caused by impacts, electrostatic levitation, and human activity (e.g., rocket exhaust, surface trafficking, and mining).

The effect of lunar dust on humans and equipment is based largely on anecdotal experience [e.g. 1]. Two detectors were designed for operation on the lunar surface: 1) the Apollo Dust Detector Experiment (DDE) [2], and 2) The Apollo 17 Lunar Ejecta and Meteorites (LEAM). The DDE was designed to measure the dust layer deposited on experiment packages during Lunar Module ascent and from long-term sources. LEAM measured the speed, direction, and total kinetic energy of particles impacting the lunar surface. There is some debate as to whether LEAM detected electrostatically levitated dust. In addition to these two surface detectors, the Lunar Atmosphere and Dust Environment Explorer (LADEE) Lunar Dust Experiment instrument was designed to detect sporadic interplanetary dust impacts, meteoroid showers, and dust particles lofted above the terminators in the altitude range of 3–250 km [3-4].

Hence, to mitigate risks, a network of near-surface sensors distributed regionally, if not globally, is needed to provide short-term and long-term monitoring of dust distributions related to human and natural factors.

**Discussion:** We are developing a compact, low-mass, low-power, low-cost, and robust particulate matter sensor. The unit will work on optical scattering principles and robust inversion algorithms will be developed to infer the particle size distribution and total concentration of levitated dust [5,6]. The device is engineered to be suitable for stationary landers and rovers, and from small-scale landers for Payloads and Research Investigations on the Surface of the Moon (PRISM) up to Artemis-scale landers. The intent is to populate the lunar surface with a network of these sensors in order to provide critical information essential for modeling dust transport and answering strategic knowledge gaps.

A single particulate analysis system would yield a better understanding of dust movement around plasma anomalies in locations such as polar craters or magnetic anomalies, and a better understanding of the interaction of rocket exhaust with lunar soil during the descent/ascent of a spacecraft (Fig. 1): for instance, revealing what causes the brightening seen around historic spacecraft landing sites [7-9].

Deploying a network of these sensors would provide a distributed data set of information critical for comprehending the long-term deposition of dust on optical and thermal radiation surfaces, and determining how far away from a habitat/other spacecraft a landing must take place to ensure the safety of the hardware. Moreover, the number of lunar landings is projected to increase over the next ten years; Hence, long-term measurements of particulate pollution would provide a picture of the exosphere’s original state and predictions for its future state. Since exospheres are the most common type of atmosphere in our Solar System—Mercury, asteroids, and icy moons of the outer Solar System—what we learn from examining the Moon’s exosphere can also be applied to optimizing the risk management of expeditions to these other nearly airless places.


Fig 1. Before-and-after images of a calibration target mounted on the end of Surveyor VI omnidirectional antenna B. Dust was kicked up during a post-landing hop. Surveyor’s three vernier thrusters were ignited for 2.5 seconds at a thrust level 667 newtons. The after image shows a coherent mass of lunar soil adhering to the vertical surface of the calibration target.