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Undergraduate Research Experiences in Granular Physics

(Physics / Arts and Sciences)

NASA is in the midst of an effort to return to the moon as part of an ongoing and permanent presence in the lunar environment. There is a limit to the amount of mass that can be lifted by state of the art rockets in the NASA arsenal. In addition to the careful selection of what needs to go to the moon in terms of fabricated materials for the construction and long term habitation of the moon, a significant portion of NASA's effort is on *in situ* resource utilization (ISRU). The ISRU program within NASA focuses on what raw materials can be obtained through the processing of the lunar regolith, the few meters of dusty moon surface that is primarily composed of the remnants of meteor impacts on the moon. This regolith is mostly silicate with different materials that are chemically absorbed within the lunar dust. The earlier missions to the moon categorized these materials within what is called the Lunar Sourcebook (Heiken, 1991). It is NASA's hope that materials as simple as oxygen and water can be processed and released from the lunar regolith to support the long term habitation of the moon.

The largest impediment of NASA's plan to use ISRU to not only support habitation but replace the need for the shipment of large amounts of oxygen and water to the lunar surface is the lack of fundamental knowledge of how to handle granular materials. While there has been a significant engineering effort to solve granular problems on a case-by-case basis – everything from packing of a foundation to the handling of grain materials to pharmaceuticals and mass produced objects such as ammunition – these problems are not going to be something that NASA wants to solve with a case-by-case effort *after* the astronauts are already on the moon. Hence, to be able to process the lunar regolith in the most flexible manner possible with the largest return of resources for the minimum of unnecessary equipment, a fundamental understanding of the physics of granular materials needs to be developed. This proposed work by undergraduates will result in papers and proposals to NASA for external support to develop a model of how energy is injected into granular systems.