LIGHT SCATTERING GRID FOR REALISTICALLY-SHAPED LUNAR DUST GRAINS: A RESOURCE FOR SURFACE AND ORBITAL INVESTIGATIONS. R. Lolachi[1,2,*], D. A. Glenar[1,2], T. J. Stubbs[2]. [1]University of Maryland, Baltimore Co., Baltimore, MD, [2]NASA Goddard Space Flight Center, Greenbelt, MD. *Corresponding author: rlolachi@umbc.edu

Abstract: Observations from the LADEE, Apollo and Surveyor missions[1,2,3] have provided evidence of an active lunar dust environment where dust is ejected from the surface into the exosphere by natural physical mechanisms (e.g., meteoroid impacts and possibly electrostatic lofting). Characterizing the spatial and temporal distribution of different exospheric dust populations, and how they are coupled to other components of the dynamic lunar environment, is important to understanding the surface evolution of the Moon.

Additionally, anthropogenic dust ejected from the surface by human/robotic exploration activities can be a significant source of exospheric dust[4,5]. Experience from the Apollo missions showed that dust has the potential to be hazardous as it can interfere with the operation of mechanical, thermal and optical systems[5]. Therefore, it is vitally important to be able to monitor the dust environment to ensure mission safety for future exploration, especially in the Artemis era[4].

An effective method for observing a dust population in the lunar exosphere is to measure the intensity of sunlight scattered by the dust. This can reveal the dust abundance and spatial distribution, as well as constrain the average grain size by measuring the angular width of the forward scattering lobe.

The largest uncertainties in such measurements lie in the grain scattering properties, namely: scattering coefficient, phase function shape and polarization. All of these become more important at larger scattering angles, where diffraction no longer dominates. Typically, the dust size distribution cannot be measured uniquely, and must be constrained by a set of forward simulations at multiple wavelengths and scattering angles.

We present a precomputed grid of light scattering properties for realistically-shaped grains building on previous work[6], which is a more accurate representation of lunar dust than the Mie models commonly employed. The grid spans UV to near-IR wavelengths and encompasses a wide range of grain size. Scattering from smaller grains is computed using the Discrete Dipole (DDA) method[7] and at larger sizes using ray tracing[8] with diffraction. Applications of this grid include observation interpretation and modelling of sunlight scattered by meteoroid impact plumes, lunar horizon glow, and exploration activities[4].

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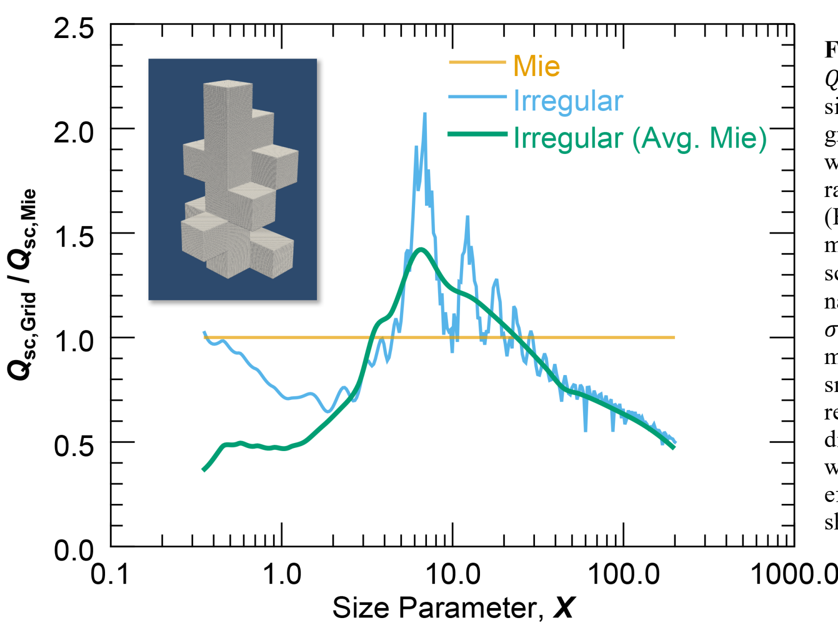

Figure 1 | Ratio of scattering efficiency, $Q_{\mathbf{sc}}$, to values predicted by Mie theory at size parameter, $X = 2\pi a_{\text{eff}}/\lambda$, for irregular grains from the grid at near-infrared wavelength $\lambda = 0.89$ µm. (Orange) Unity ratio for Mie values shown for reference. (Blue) Ratio of scattering efficiency for monodisperse Mie values. (Green) Ratio of scattering efficiency for Mie values with a narrow log-normal distribution in a_{eff} with $\sigma = 0.2$ µm. This functions as a pseudo-monodisperse size distribution, but smoothes out Mie resonances and is a more realistic representation. In both cases large differences from unity are seen. In other words, shape has a huge effect on scattering efficiency. **Inset:** Irregular grain DDA shape model.