LIGHT SCATTERING BY DUST IN THE LUNAR EXOSPHERE. T. J. Stubbs[1] and D. A. Glenar[2], [1]Solar System Exploration Division, NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA, [2]University of Maryland, Baltimore County, Baltimore, MD 21250, USA. Timothy.J.Stubbs@NASA.gov

Evidence for light scattering by dust in the lunar exosphere unexpectedly came from a few different sources during the Apollo-era. This was surprising since the typical abundances of ejecta anticipated from meteoroid impacts would not have scattered sufficient sunlight to be optically detectable [1, 2]. However, observations of a "lunar horizon glow" (LHG) were reported close to the surface in post-sunset images from the Surveyor lander TV cameras [1]; as well as from orbit while in the shadow of the Moon, both in coronal photographs [2] and visually by astronauts, as captured in their sketches [3]. Complementary optical observations were provided by the astrophotometer on the Soviet Lunokhod-II rover that detected a brighter than expected lunar twilight sky [4]. At about this time, there was also evidence for dust movement from in situ measurement at the surface; in particular, the Apollo 17 Lunar Ejecta And Meteorites (LEAM) experiment appeared to detect slow-moving, highly-charged dust, especially around sunrise [5]. Therefore, electrostatic processes were proposed as providing mechanisms for transporting charged dust to explain the greater than expected abundances inferred from observations [1, 2]. However, most of these observations and the various interpretations remained controversial.

Much later, the Apollo coronal photographic sequences were reanalyzed to reveal that only one of them showed any evidence for LHG, referred to as an "excess brightness" above that expected from coronal and zodiacal light (CZL) [6]. Therefore, rather than being a common occurrence, observing LHG from orbit appeared to be relatively infrequent. In the small number of sequences obtained, there was no obvious connection to solar wind or solar UV conditions, which appeared to rule out electrostatic transport as the dominant mechanism. The detected excess brightness occurred during an Apollo 15 orbital sunset (sunrise at the surface) around the same time as a couple of meteoroid streams, so it was speculated that the LHG could have been related to dust ejected from impacts [6].

In 1994 the Clementine star tracker navigation cameras were used to search for LHG from orbit, but were initially inconclusive [7]. More recently it has been shown that Clementine did not detect LHG, and that the derived upper limits were below the abundances inferred from the Apollo 15 coronal photographic sequence.

Similarly, a campaign to search for LHG using the Lyman-Alpha Mapping Project (LAMP) FUV spectrograph, which adopted a comparable viewing geometry to the Apollo observations, also only produced upper limits [8].

The Lunar Atmosphere and Dust Environment Explorer (LADEE) mission had an objective to "Characterize the lunar exospheric dust environment and measure any spatial and temporal variability and impacts on the lunar atmosphere", which was motivated by the contentious observations from the Apollo era [9]. The LADEE Lunar Dust Experiment (LDEX) made the first in situ detection of the Moon's impact-generated dust cloud, which revealed that it had higher abundances around the sunrise, which faces the direction of the Earth-Moon system's orbit about the Sun [10]. From these observations, it has been possible to produce steady-state models for the global distribution of lunar ejecta cloud [11]. LDEX occasionally detected bursts of ejecta that were interpreted as being encounters with fresh ejecta plumes [12], which for substantial impacts may be related to LHG [6].

The LADEE Ultraviolet Visible Spectrometer (UVS) has so far not reported any Apollo 15-like LHG, but did infer the presence of a large-scale cloud of nanodust around the Moon that appeared to be modulated by meteoroid streams [13]. LRO/LAMP followed up with a series observations with similar viewing geometries during the same meteoroid streams, but did not detect any nanodust [14]. This discrepancy may been due to differences in conditions that could affect the transport of nanodust [14].

Most recently, the LRO/LAMP observations from the search for LHG have been revisited to determine whether a refined analysis could reveal evidence of the impact-generated ejecta cloud, now that its characteristics have been constrained by the LDEX observations [15]. If successful, these would be the first optical detections of the Moon's ejecta cloud, which would be sensitive to smaller grain sizes than LDEX and provide a quasi-instantaneous view of its large-scale morphology. This analysis could also guide future observations with LRO/LAMP that could help constrain the global properties of the ejecta cloud, as well as inform the design and operations of future optical instruments.

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