SEARCH FOR A HIGH ALTITUDE DUST EXOSPHERE: OBSERVATIONAL STATUS PRIOR TO THE LADEE MISSION.

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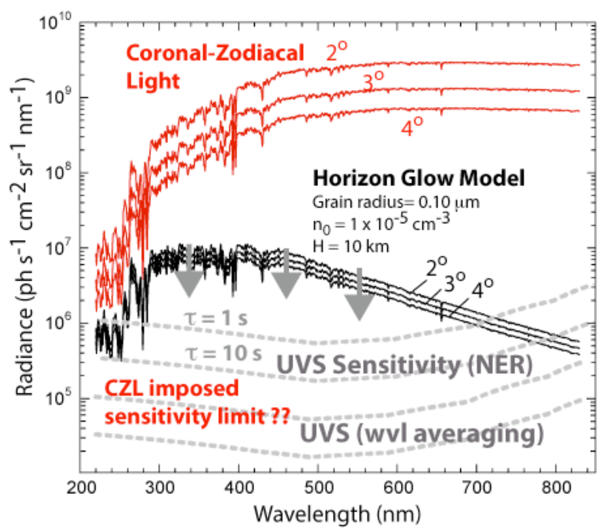
Introduction: Optical measurements during the Apollo missions produced evidence that the Moon has a significant, and perhaps sporadic, high altitude dust exosphere composed of “tenth micron” dust grains. The lines of evidence include Apollo 17 visual observations before orbital sunrise of rapidly brightening crepuscular rays [1] and extended horizon glow [2], neither of which could be explained by solar coronal-zodiacal light or coronal streamers. Further evidence came from excess brightness measurements in photometrically calibrated coronal photography during Apollo 15, leading to the McCoy dust “model 0” [3]. A reanalysis of those measurements in terms of small (~0.10 μm radius) grains [4] reaffirmed the McCoy dust estimates which predicts tangential LOS (line of sight) concentrations up to ~10^5 gr cm^{-2}. The McCoy results were also used to make some initial predictions for horizon glow as it migt be observed by the LADEE Ultraviolet Spectrometer (UVS) [6].

However, measurements since the Apollo missions contradict the notion of a substantial dust exosphere and raise new questions about the interpretation of those original measurements and the state of the exosphere at those times. An analysis of 1994 limb searches by the Clementine star trackers found no convincing evidence for a dust exosphere, down to a LOS detection limit of < 1000 r=0.1 μm grains cm^{-2}, after correcting for coronal-zodiacal light (CZL) [7].

Dust Upper-Limits from LRO LAMP: At present, LRO LAMP has completed a number of observations from within lunar shadow, to search for forward scattering of sunlight at the sunrise or sunset limb. Far-UV measurements are especially sensitive to scattering by small (0.1-0.2 μm radius) dust grains since the scattering cross section is near maximum. No definitive detection of dust has yet been made by LAMP, although weak excess brightness has been observed after correcting for grating scattered light. These results have been coarsely matched to 1D exponential upper-limit dust models with surface concentration n_0~10^{-5} cm^{-3} and H= 5-10 km [8]. This represents a far more tenuous exosphere than Apollo-era predictions, and lowers the expectations for bright horizon glow observable during the LADEE mission.

Implications for the LADEE UVS Dust Search: The figure shows the spectral brightness of horizon glow as it might be observed by UVS at 3 different solar depression angles (Sun just below the horizon). These simulations (black lines) were computed using an exponential dust model that is consistent with the LAMP-derived upper limits. Model radiances remain several times larger than the detection limit as measured for the UVS Engineering Test Unit, meaning that UVS should ultimately achieve better dust detection sensitivity than LAMP. Wavelength averaging will further improve the detection margin.

Coronal-zodiacal light (red lines) will likely be the dominant source of brightness at the small solar elongation angles observed by UVS. This will require careful subtraction using prior measurements of CZL spatial and spectral characteristics [9].



References: [1] McCoy J. E. and Criswell D. R. (1974) *LPS V,* Abstract #2991. [2] Zook H. A. and McCoy J. E. (1991) *Geophys. Res. Lett., 18,* 2117-2120. [3] McCoy J. E. (1976) *LPS VII,* Abstract #1087. [4] Glenar D. A. et al. (2011) *Planet. Space Sci., 59,* 1695-1707. [6] Stubbs T. J. et al. (2010) *Planet. Space Sci., 58,* 830-837. [7] Glenar D. A. et al. (2012) *Lunar Sci. Forum, July.* [8] Glenar D. A. et al. (2013) *Lunar Sci. Virtual Forum, July.* [9] cf. Hahn J. M. et al. (2002) *Icarus 158,360-378.*