LUNAR HORIZON GLOW AND THE LUNAR DUST EXOSPHERE

H. A. Zook and J. E. McCoy, NASA-Johnson Space Center, Houston, TX 77058

While in orbit about the Moon, and while occulted from the sun, the Apollo 17 astronauts both photographed and sketched (Dec., 1972) the light of the night sky as viewed over the nighttime lunar horizon. The purpose of these observations was to obtain quantitative data on the brightness of the F-corona and zodiacal light (CZL) as a function of solar elongation and latitude. McCoy and Criswell (1) and McCoy (2) later deduced, however, that some of the observed light was clearly of local origin, and they suggested that the extra light was due to scattering by a dust cloud above the Moon. In addition to the CZL and the "excess" light earlier analyzed (1,2), there was also a "horizon glow" of light that extended broadly along the lunar horizon and that was sketched by all three Apollo 17 astronauts (1). This horizon glow has not been previously analyzed. We show in this paper that it is probably due to a lunar dust exosphere with an exponential scale height of 5 to 10 km; we ignore, for now, the CZL and the excess light.

Figure 1 is a reproduction of a sketch by Apollo 17 Command Module Pilot R. E. Evans that gives his impression of an isophote of light intensity over the lunar limb (shown upside down in his sketch). The central bulge of light is probably mostly due to CZL, and the streaks are part of the excess light previously analyzed (1). We focus our attention only on the thin layer of light that appears to closely follow the lunar horizon--the "horizon glow." Figure 2 shows the results of a numerical analysis of the expected shape of dust-scattered light isophotes above the lunar surface, where it was assumed that the dust density fell off with altitude above the lunar surface as $e^{-H/HS}$, where HS = 10 km (the scale height) in this example. It was further assumed that the dust grains were very small and that they scatter light isotropically. It is seen at once that there is a striking resemblance between Evan's sketch and our model, if one allows for the fact that lunar curvature and CZL are not shown in Fig. 2. One notes a very steep fall-off of intensity with elevation angle above the lunar surface. We have also modeled contaminant clouds uniformly concentrated near orbital altitudes (about 110 km) and find that one expects the brightness, in those cases, to peak several degrees <u>above</u> the lunar horizon--a condition clearly in contradiction with the astronauts' horizon glow observations. In fact, we can think of no way that S/C contamination clouds can give rise to the astronauts' observations. For reasons given in (1,2) it is very unlikely that the scattering is due to a lunar gas atmosphere; lunar dust is the only reasonable alternative.

Although the horizon glow is apparently not seen in the Apollo CZL photography, supporting evidence of its existence is deduced from the Lunokhod 2 observations, where Severny et al. (3) noted that the lunar night sky in the vertical direction was still quite bright (about $4x10^{-12}B_s$, where B_s is the brightness of the sun) two hours after sunset on this vehicle. Probably related are the observations of Berg et al. (4) who deduced clear evidence of electrostatic transport of dust over the lunar surface that was especially intense near local sunrise and sunset. It should be noted that the horizon glow sketched by the Apollo 17 astronauts is of much greater scale height than the several tens of centimeters scale heights deduced by Rennilson and Criswell (5) for the low altitude horizon glow observed after sunset by the Surveyor spacecraft that had landed on the Moon. The two horizon glows are probably closely related, however, and may merely differ in sizes and scale heights of dust grains involved. Finally, it should be possible to observe the lunar dust telescopically from Earth; because the grains are expected to be small (perhaps 0.1 μm or so in diameter), they should preferentially scatter blue light over red light, and the light should be almost 100% polarized at 90 degrees scattering angle. The only problem is separating this light from other sources of light such as Earth-shine, or light scattered in the upper atmosphere of the Earth or inside the telescope.

REFERENCES: (1) McCoy J.E. and Criswell D.R. (1974) Proc. Lunar Sci. Conf. 5th, pp. 2991-3005. (2) McCoy J.E. (1976) Proc. Lunar Sci. Conf. 7th, pp. 1087-1112. (3) Severny A.B., Terez E.I., and Zvereva A.M. (1975) The Moon, 14, 123-128. (4) Berg O.E., Wolf H., and Rhee J. (1975) In: Interplanetary Dust and Zodiacal Light (H. Elsasser and H. Fechtig, eds.), pp. 233-237. (5) Rennilson J.J. and Criswell D.R. (1974) The Moon, 10, 121-142.

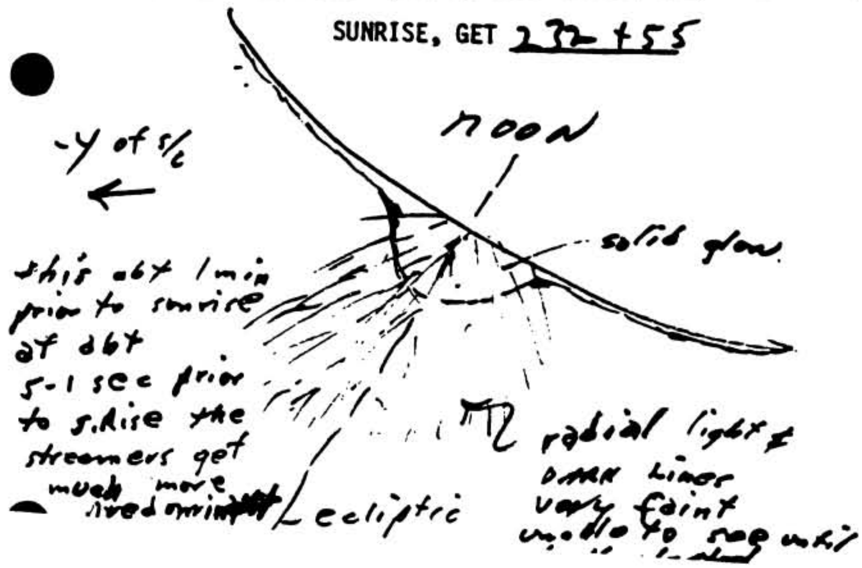

Fig. 1. Sketch by Apollo 17 Command Module Pilot R. E. Evans depicting sunrise features over the lunar horizon.

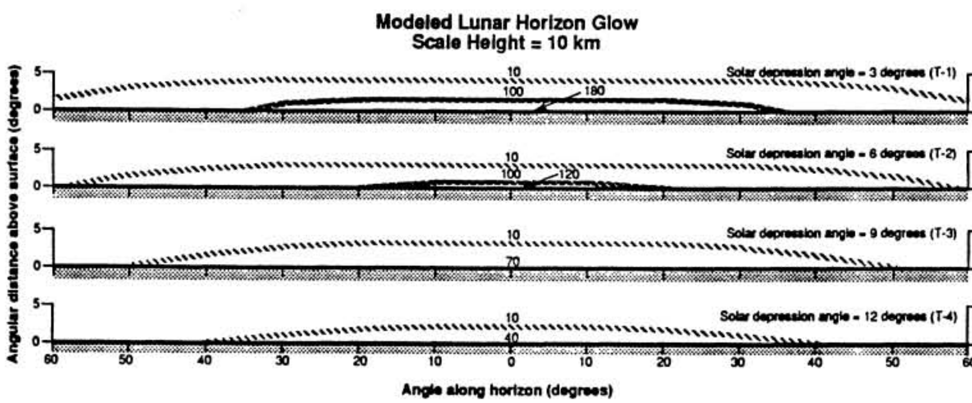

Fig. 2. Horizon glow isophotes expected from a lunar dust exosphere with a scale height of 10 km (and isotropic scattering assumed). Isophote units are arbitrary.