

Possible evidence of dust lofting observed at the lunar polar region

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Observation of dust levitation (surface regolith lofting) was reported for the lunar surface since the Apollo era. Nevertheless, all earlier observations were of levitation phenomena at the terminator region (day–night boundary) for levitation believed to occur by charging of the regolith grains by solar wind. Furthermore, arguments related levitation remain active because few items of observational evidence exist. Though observations of impact-generated dust clouds (not levitating dust) caused by meteorite impacts on the lunar surface have been reported, observational data of levitated or impact-generated dust lofting have not been reported for lunar polar regions. This study investigated dust lofting phenomena at the lunar polar region by analyses of visible and near-infrared spectral data for 512–1680 nm wavelengths obtained using the Spectral Profiler (SP) onboard SELENE (Kaguya) during nighttime. Data obtained by the SP for latitudes greater than 80° near the North and South poles were evaluated. Multiple screening procedures revealed more than 5000 datapoints having an “irregular signal” among the nighttime observation data. We checked the observation configuration (e.g. viewing geometry and illumination condition of the lunar surface at the time of each observation) of several of the selected irregular signals and confirmed that these signals had not originated from the lunar surface because the lunar surface was not illuminated directly by the Sun or by reflected light. Additionally, we checked and eliminated other possibilities such as stray light, calibration error, and Earthshine as signal sources. From the results, we inferred that these signals originated from the upper space unattached from the lunar surface (and not originated from the lunar surface): 15 to approximately 100 km above the surface depending to the satellite altitude at the time of the observation. For illustration, when a satellite passes from the dayside to the nightside at the polar region in a polar orbit, the satellite and space surrounding it will be illuminated by the Sun for a certain time even after the satellite enters the nightside. Therefore, our identification of the irregular signals suggests that the light source of the signal is lofted dust distributed in upper space, subsequently illuminated and reflecting sunlight. Additionally, we checked the intensity, spectral shape, frequency, spatial distribution, and occurrence (timing) of the irregular signals in relation to major meteor showers to elucidate the origin (levitation or impact) of the lofted dust. Most identified irregular signal data were consistent with the levitation origin, although we cannot rule out meteorite impacts as an explanation for some data.

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