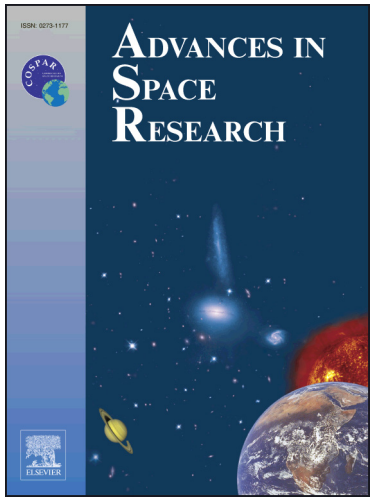

Laboratory measurements of light polarization on samples targeted for the lunar regolith

Il-Hoon Kim, Suk Kyung Sung, Sungsoo S. Kim, Minsup Jeong, Chae Kyung Sim, Kilho Baek, Kap-Sung Kim, Young-Jun Choi

PII: S0273-1177(16)30755-4
DOI: http://dx.doi.org/10.1016/j.asr.2016.12.033
Reference: JASR 13032

To appear in: *Advances in Space Research*

Please cite this article as: Kim, I-H., Sung, S.K., Kim, S.S., Jeong, M., Sim, C.K., Baek, K., Kim, K-S., Choi, Y-J., Laboratory measurements of light polarization on samples targeted for the lunar regolith, *Advances in Space Research* (2016), doi: http://dx.doi.org/10.1016/j.asr.2016.12.033

Laboratory measurements of light polarization on samples targeted for the lunar regolith

Il-Hoon Kim[a], Suk Kyung Sung[b], Sungsoo S. Kim[a,b,*], Minsup Jeong[b,c], Chae Kyung Sim[b], Kilho Baek[b], Kap-Sung Kim[a], and Young-Jun Choi[c]

[a] *Dept. of Astronomy & Space Science, Kyung Hee University, Youngin, Gyeonggi, 17104, Republic of Korea*
[b] *School of Space Research, Kyung Hee University, Youngin, Gyeonggi, 17104, Republic of Korea*
[c] *Korea Astronomy and Space Science Institute, Daedeokdae-ro 776, Yuseong-gu, Daejeon, 34055, Republic of Korea*

Abstract

We carried out multi-band (B, V, and R bands) polarimetric measurements of several soil samples targeted for the lunar regolith (JSC-1A, Fe_2O_3, SiC, and JSC-1Mars). Our laboratory experiments are intended to provide some constraints to the theoretical and numerical studies of the light scattering off the particulate surface of airless bodies in the solar system. Among our samples, the lunar soil simulant JSC-1A has the closest $\alpha_{\max}$ to the typically observed value on the lunar surface, $\sim 100^\circ$, where $\alpha_{\max}$ is the phase angle at which the polarization has the maximum value. In the other samples, $\alpha_{\max}$ is higher than 120° or significantly wavelength dependent. The empirical relationship between the grain size, maximum polarization and albedo for the lunar regolith overestimates the actual grain sizes of some of our samples by a factor of up to ~ 6. The measured polarization degrees and albedos of the JSC-1A sample are similar to the typical observed values of the lunar maria. We also find that the wavelength dependence of both polarization degree and albedo is larger for smaller-grain samples.

Keywords: Polarization; Laboratory; Moon; Planets and satellites; Surface

1. Introduction

The first systematic study on the polarimetry of the Moon was started by Lyot (1929). Coffeen (1965) measured the degree of polarization, P, of volcanic cinders and particles as a function of wavelength and found that P is larger at shorter wavelengths. However, Egan (1967) showed that P can be smaller at shorter wavelengths in few certain samples.

Studies on the polarimetry of the airless bodies in the solar system such as the Moon were mainly carried out in 1960's and 70's with the observations from the Earth's ground in preparation for the lunar landing missions (e.g., Clarke, 1965; Coffeen, 1965; among others). After the Luna and Apollo missions, a few polarimetric experiments were performed in a laboratory using the lunar samples returned from these missions (e.g., Bowell et al., 1972; Geake et al., 1970). However, most polarimetric experiments in the laboratory have been carried out using terrestrial volcanic samples or lunar soil simulants due to the limited availability of the lunar samples. Levasseur-Regourd et al. (2015) review previous laboratory polarization measurements of light scattered by particulate surfaces of airless bodies.

An inverse linear correlation between $\log A$ and $\log P$ was first found for the lunar regolith by Umov (1905). This finding was confirmed with measurements of the terrestrial samples (Dollfus et al., 1971) and observations of the lunar surface (Shkuratov and Opanasenko, 1992). This effect has also been theoretically modelled by Grynko and Shkuratov (2008) and Zubko et al. (2011).

The relationship between the grain size and P of the soil was studied by Dollfus et al. (1971) using a 6000Å light source and 61 different kinds of rocks. They showed that the particle size was proportionate to P and that the P value of the particle size of 25 – 60 μm was well consistent with that of the Moon. Dollfus and Titulaer (1971) found that the polarization properties of the lunar

*Corresponding author
Email address: sungsoo.kim@khu.ac.kr (Sungsoo S. Kim)