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Laboratory simulation of light scattering from regolith surface

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Abstract

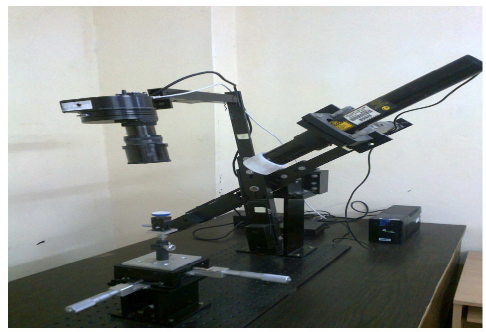
The study of light scattering by planetary regolith has been and still is a subject of great interest in many different scientific disciplines for many years. Measurement of light scattered from such surface provide information about the composition and structure of the surface. Here in Assam University, Silchar, India we have set up a laboratory to simulate the light scattering properties of such surface. Results obtained by the above experiment will be discussed.

1. Introduction

The surfaces of most atmosphere less solar system objects are referred to as regolith or layers of usually loosely connected fragmentary debris, produced by meteorite impacts. Light scattering is a useful tool to infer the physical properties of regolith surfaces. A suitable way to characterize the scattering properties is to consider how the intensity and polarization of scattering depends on the particle size, composition, porosity, roughness, wavelength of incident light and the different geometry of observation.

2. Instrumental Details

The laboratory simulation was performed with the help of a gonio-photometric device (fig-1) at the department of Physics, Assam University, Silchar, India. It consists of two metal arms having a common horizontal axis of rotation. The sample surface is placed at the axis of rotation of the arms with the help of three translation stages. A miniature goniometer acts as a tilting device to the sample. The two arms can be rotated by ±90º from the zenith direction and a tilt up to ±20º can be given to the sample from the horizontal position perpendicular to the plane of scattering. We have used He-Ne laser at wavelengths 543.5nm (green) as the source of light and the CCD camera as the detector. For imaging a thick lens [converging] is mounted in front of the CCD camera The sample is placed at the common intersection of the axis of rotation and axes of the source and detector. The sample prepared for our measurement is made up of basalt rock having particle size 20-32 micron.



3. Measurement and Data analysis

The tilt angle of the sample was kept fixed at 0_ for simplicity to begin with. The detector angle or emergent angle (e) was also kept fixed at -18^0 (anticlockwise when viewed from the front) from the zenith. The angle of incidence (i) was varied from 0^0 to 45^0 in steps of 9 (which was equivalent to rotation by five divisions of the attached circular scale). Outside the said range of incidence angle, the laser spot did not exactly pass through the axis of rotation,due to the limitation on our mechanical assembly. Thus the phase angle (g) was varied from 18^0 to 63^0. The images of sample surface were recorded at every angle of incidence in the form of FITSimage.

4. Theory

The bi-directional reflectance r(i,e,g) is defined as the ratio of the reflected intensity (I) to the incidence irradiance (J).

The intensity of the scattered beam depends on these three angular parameters. The bidirectional reflectance '*r*' as a function of *i*, *e* and *g* is given by

$$r(i,e,g) = I(i,e,g) / J$$

The interrelation among the angle of incidence *i*, detector angle *e*, the phase angle *g* and the tilt angle Φ is given by:

$\cos g = \cos i \times \cos e + \sin i \times \sin e \times \cos\Phi$ [1]

Result & Discussion

Bidirectional reflectance, measured for the Basalt sample having particle size 20-32 micron are shown in Figs. 2 and 3 as a function of phase angle. The data shown in Fig. 2 at zero tilt angle. Figure 4. represents variation of tilt angle at fixed Detector and source angle.

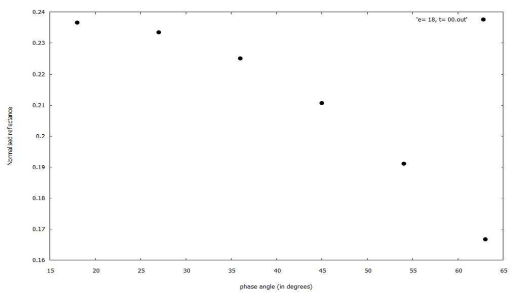


Figure2:emergence angle=18[Fixed],incidence angle=0^0 to 45^0 tilt angle=0^0 (fixed)

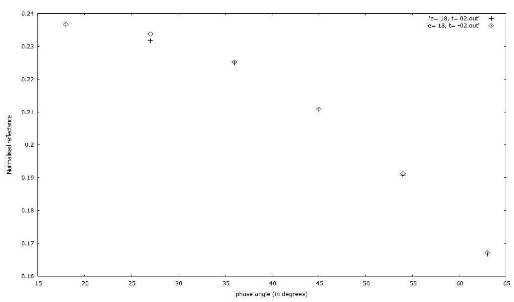


Figure 3: Emergence angle=18[Fixed], Incidence angle=0^0 to 45^0 Tilt angle=2^0 to -2^0

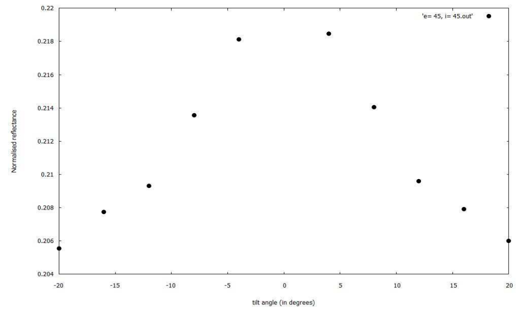


Figure4: emergence angle=45^0, incidence angle=45^0 [Fixed], tilt angle=20^0 to -20^0

From the figure 2 it appears that the phase curve for tilt angle zero for fixed detector angle and by varying incident angle have a decreasing trend. figure 3 represents that for different tilt angle making same angle on either side of horizontal base show similar pattern. And from figure 4 a significant influence of variation of tilt angle is observed.

Acknowledgements

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References

[1] Bhattacharjee C.,Deb D.,Das H.S.,Sen A.K.,Gupta R., 2011 PASA 28(3),261-265