EPSC Abstracts
Vol. 12, EPSC2018-1259, 2018
European Planetary Science Congress 2018

Reflectance measurements of satellite materials

Antti Penttilä (1), Olli Wilkman (2), Sonja Lahtinen (2), Maria Gritsevich (1), Jesús Escobar-Cerezo (1), and Karri Muinonen (1,2)
(1) Department of Physics, University of Helsinki, Finland (antti.i.penttila@helsinki.fi); (2) Finnish Geospatial Research Institute FGI, National Land Survey of Finland.

1. Introduction

The electromagnetic radiation introduces a force, the radiation pressure, when absorbing or reflecting from a material. This force is very small and can usually be neglected on the Earth, but can be detectable for objects in space, especially when studying their orbits over time.

In our ongoing ambitious project we are relating the radiation pressure that the Global Navigation Satellite System (GNSS) satellites are experiencing to the albedo of the Earth. The albedo of the Earth is the ratio between the emitted and incident radiation by the Earth, and is a key parameter in understanding the global temperature balance of the Earth and its climate.

The main radiation component for the satellites is the direct sunlight ($\sim 10^{-6}$ pascals), but radiation reflected and emitted by the Earth is the second largest radiation component ($\sim 10^{-8}$ pascals). On the other hand, the satellite orbits are constantly observed by different satellite laser ranging stations around the globe. With the models for their orbits, one can remove all the other known effects and observe the radiation pressure force component that they are experiencing at different times and positions. This force component is now due to the radiation component from the Earth. By observing many satellites at the same time we invert the global albedo, integrated over the 4π solid angle, of the Earth.

One parameter that is needed in the model is the reflectance and absorption properties of the GNSS satellites. These quantities need to be measured for the typical satellite surface materials.

2. Optical properties of satellite materials

We will acquire typical surface materials of satellites, with the typical solar panel materials being the most important regarding the radiation pressure. We will measure the spectral bi-directional reflectance distribution function (spectral BRDF) of these with our LightTec Reflet 180S spectro-goniometer. This device can measure the angular reflectance with any illumination direction. This can be done with visual- and near-infrared wavelengths up to 1 µm.

For ultraviolet (starting from 0.25 µm) and near-infrared up to 3.2 µm, we can measure the integrated (over the hemisphere) reflectance spectra with our Gooch & Housego OL750 spectroradiometric system [1]. The spectral BRDF for these wavelengths can be estimated by combining the BRDF for other wavelengths with the albedo integrated over the hemisphere for these wavelengths.

The measured spectra are finally applied to 3D satellite shape models in a simulation of spacecraft reflection properties. This simulation can be used to model e.g. photometry, spectrometry and radiation pressure forces on satellites.

Acknowledgments

The work is supported by the Academy of Finland, project 298137.

References

[1] Penttilä, A., Martikainen, J., Gritsevich, M., and Muinonen, K.: Laboratory spectroscopy of meteorite samples at UV-vis-NIR wavelengths: Analysis and discrimination by principal components analysis, Journal of Quantitative Spectroscopy & Radiative Transfer, Vol. 206, pp. 189–197, 2018.