EXPERIMENTAL MEASUREMENT OF THE PHASE FUNCTIONS OF METEORITES AND TERRESTRIAL ROCKS: COMPARISON WITH THEORY AND OBSERVATIONS OF ASTEROIDS. F. Capaccioni,* M.A. Barucci,** P. Cerroni,* and M. Fulchignoni.*** * I.A.S. Reparto di Planetologia, Viale Dell' Università 11, 00185 Roma; ** Laboratorio di Scienze Planetarie -- Teramo Obs.; *** Istituto di Astronomia -- Università di Roma, all in Italy.

The measurement of the radiation reflected by a particulate surface as a function of the phase angle can be a powerful means to infer some information on physical and chemical properties of the materials making up the surface layer of atmosphereless bodies of the Solar System. Several theoretical descriptions of light scattering by a particulate surface have been developed[1,2,3,4] to explain the observations of the phase functions for a number of Solar System bodies (asteroids, satellites of Jupiter, the Moon, and Mercury).

However, laboratory measurements are lacking for naturally occurring materials, both terrestrial and extraterrestrial, needed to improve the understanding of the physics of the processes involved.

The authors started an experimental program at the Teramo Observatory to study the reflectance of pulverized meteorites and terrestrial rocks at various phase angles.

The experiments were performed using a refined version of photometric goniometer available at the Teramo Observatory. The apparatus uses a tungsten halogen light-source illuminating the powdered samples vertically; the photometer is mounted on an arm that moves to achieve variation in phase angle, which in this case is equal to the emission angle. Light source, samples, and detector are coplanar; the values of the phase angle vary between approximately 2 and 45 degrees, with a mean error of 0.25 degrees.

We analysed the reflection of 19 meteorites, kindly provided by the Vatican collection housed at the Vatican Observatory in CastelGandolfo. Among the chondrite classes we had: 3 C-type, 6 L-type, 4 H-type, 2 LL-type, and 1 E-type; furthermore, we used three achondrites, namely: Chassigny (chassignite), Juvinas (eucrite), and Pavlovka (howardite). Small specimens (up to 2 g) of each meteorite were ground with an agate mortar and pestle, to obtain a powder consisting of grains of dimension up to approximately 500 µm. An analogous operation was performed on the 3 terrestrial rocks, namely diabase, peridotite, and quartz-rich sand, but, additionally, the resulting powders were classified into 6 size-fractions (ranging from 800 µm down to less than 50 µm) by dry sieving.

All the reflectance measurements were normalized to the reflectance of freshly deposited MgO, taken as a perfectly diffusing surface. Additional measurements were performed on carbon-black samples.

A systematic study of the effects on the phase curve of varying the size fraction has been carried out using the terrestrial rocks. An increase in the overall brightness of the surface ana less-pronounced opposition effect has been observed with decreases in the average particle radius. The quartz-rich sand and carbon-black samples exhibit a lack of defined opposition effect, in the range of phase angles and size fractions studied.

The meteorite phase functions can be classified mainly on the basis of the meteorite's albedo, with the carbonaceous chondrites being the darkest, and the achondrites and the more petrographically evolved types of the H and L chondrites being the brightest. In each meteorite class, the shape of the phase curve seems to be related to the petrographic type (the curves being steeper for the less-evolved petrographic types), while no significant differences can be observed in the shape of the curves of meteorites belonging to different classes, thus confirming the belief that the shape of the phase curve is mainly determined by surface texture. More quantitative considerations will be derived from a detailed analysis of the phase curves in terms of the parameters involved in the theoretical description of light scattering by a particulate surface.[1,2,3,4]

Finally, similarities between the phase curves of meteorites and asteroids have been investigated comparing our experimental results with several tens of asteroidal phase-functions available in the literature.[5]

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