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Light scattering by dust particles (PROGRA^2 experiment): size and structure effects for transparent and absorbing materials

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1- Introduction

Cometary and possibly interplanetary dust particles seem to be mainly made of agglomerates of submicron and micron-sized grains. These particles are among the most primitive in our solar system. Regoliths on asteroidal and planetary surfaces seem to be loose materials produced by impinging meteorites on the surface of small bodies. Comparing their physical properties is thus fundamental to understand their evolution. To interpret remote observations of solar light scattered by dust particles and regoliths, it is necessary to use numerical and experimental simulations [1,2,3].

2- PROGRA^2 experiment

PROGRA^2 instruments are polarimeters; the light sources are two randomly polarized lasers (632.8 nm and 543.5 nm). Levitating particles (in microgravity or lifted by an air-draught) are studied by imaging polarimetry. Details on the instruments can be found in [4,5].

3- Samples

Two kinds of samples are studied: compact particles in the (1-400) micrometer size range and fluffy aggregates in the same size range, made from submicron and micron-sized grains. The materials are transparent silica and absorbing carbon. Some deposited particles are huge agglomerates of micron-sized grains produced by random ballistic deposition of single grains [6,7] or produced by evaporation of mixtures in alcohol of fluffy aggregates of submicron-sized grains. Two samples are made of silica spheres coated by a carbonaceous black compound. Cometary analogues are mixtures of silica and amorphous carbon or Mg-Fe silicates mixed with amorphous carbon.

4- Results

Phase curves and their main parameters (negative polarization at small phase angles and maximum polarization, Pmax, at 90-100˚ phase angle) for the different materials will be compared and related to the physical properties.

For example, it is well known by numerical simulations and/or by experiments that the maximum polarization decreases when the size (submicrometer range) of the grains increases [2,8,9]. An inverse rule is found for compact grains, larger than the wavelength. Mixtures of fluffy silica and fined grained amorphous carbon or better Mg-Fe silicates with amorphous carbon are excellent cometary particles analogues (as light scattering is concerned) if they are mixed with some compact micron-sized grains [9]. Nevertheless the structure of the aggregates seems to play a major role to obtain the negative branch found on the polarimetric phase curves for comets [10].

5- Discussion and conclusions

The experiments purpose is to help to disentangle the different physical properties of dust particles that can be deduced from remote observations (cometary dust, regoliths). Differences between the main parameters influencing the variations of Pmax and the presence of a negative branch on the polarimetric phase curves for lifted and deposited particles (in huge agglomerates or not) will be discussed.

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