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Light scattering by Cometary dust particles analogs

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Abstract

Polarimetric observations of cometary comae may be used to infer dust properties through experimental simulations. Mixtures of fluffy silicates and carbon were successfully studied and confirmed the results from remote observations. New samples are proposed to better represent the particles observed in comets with important dust activity or less active comets without important jet emissions or before perihelion. Different organics, which can be eventually heated, are also studied. The samples are lifted in low-density cloud in the PROGRA2 light scattering experiment.

1. Introduction

Solid particles observed in cometary comae after their ejection from the nucleus and after evaporation of the more volatile ices mainly consist of silicates and carbon-compounds. They seem to be made of fluffy aggregates of tiny µm-subµm-sized grains mixed with some compact particles as found in some IDPs and particles captured by Stardust or in micro-meteorites.

Laboratory simulations of light scattering by cometary analog particles help to disentangle different physical properties by comparison with observational data [1]. The linear polarization depends on the geometry of the observations (phase angle), the particles properties (size distributions, structures, refractive indices) and on the wavelength of observations. Whole coma polarization and coma regions observed by polarization imaging [2] are tentatively interpreted by the laboratory studies.

2. Light scattering experiment

The samples are introduced in a vial and studied in microgravity or lifted by an air-draught (depending on the porosity of the particles) [3]. The linear polarization of the scattered light is measured as a function of the phase angle in two wavelengths. The polarization phase curves and their parameters are compared to phase curves obtained from observations.

3. Samples and results

Vapour-condensed silicates (Mg-SiO-H2-O2 and Fe-SiO-H2-O2) were mixed with industrial carbon-black [4]. The aggregates constituent grains have subµm-sized grains. To fit the whole coma polarization values (observed through large apertures), more compact silicate aggregates with tens µm-sized grains are added to the mixture [3]; with only fluffy particles, the phase curve corresponds to values of polarization in jets. The presence of carbon-black is necessary to obtain the positive spectral gradient in the visible wavelength domain (increase of polarization with increasing wavelength) as generally observed in comets.

A region relatively close to the nucleus is also sometimes observed, the so-called polarimetric halo, with a lower polarization at large phase angles and a deeper polarization at small phase angles. Transparent materials seem to be requested. We proposed the eventual presence of carbonaceous compounds with refractive indices similar to those of silicates; which cover or are mixed to silicates [3]. These materials when heated after ejection may be modified in materials darkening progressively. These

dark particles, further away in the coma, will be mixed to the other particles.

4. New materials

4.1. Organics

In cometary particles the organic refractories are poorly known. Analogs are tentatively produced in laboratories by different methods: from liquids (poly-HCN), or from molecules dissociation in N2:C0:CH4:H2:H2O gas mixtures in different ratios by an electric discharge where electrons from the plasma initiate a gas-phase chemistry. Finally clear to dark brown solid particles are formed in the gas phase with the PAMPRE/LATMOS instrument [5] and dark solids are deposited on the walls in the nebulotron/CRPG-CNRS [6]. The organics are different in size distribution and composition depending on their formation conditions. Their elemental composition e.g. N related to C depends on the formation conditions and the colour is related to the chemical functions. Some of these organics are heated ex-situ. The different organics are analyzed with SEM, TEM, IR and Raman spectroscopy. Their optical properties are compared using the PROGRA2 experiment and the results are tentatively related to their composition. They are finally mixed to silicates.

4.2 Mixtures and coated silicates

Mixtures of Mg and Fe silicates (from NASA and CRPG) with carbon and different organics are studied to evaluate their influence on polarization of the scattered light in the mixture. On the other hand, some samples with organic coatings are also studied [Johnson].

5. Summary

Some dust analogs, silicates and organics, are produced. Some of their similarities with cometary particles will be underlined and the scattered light will be compared to remote observations.

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References

[1] Levasseur-Regourd, AC., and Hadamcik, E., Light scattering by irregular dust particles in the solar system: observations and interpretation by laboratory measurements, IQSRT Vol. 79-80, 903-910, 2003.

[2] Hadamcik, E., et al. This conference, Session SB6.

[3] Hadamcik, E., Renard, J. -B., Levasseur-Regourd, A. C., Lasue, J., Laboratory measurements of light scattered by clouds and layers of solid particles using an imaging technique. In: Polarimetric detection, characterization, and remote sensing (Mishchenko, et al. Eds.), Springer, Dordtecht, The Netherlands, 137-176, 2011.

[4] Hadamcik, E., Renard, J.-B., Rietmeijer, F. J.M., Levasseur−Regourd, A.C., Hill, H. G. M., Karner, J. M., and Nuth, J. A., Light scattering by fluffy Mg-Fe-SiO and C mixtures as cometary analogs (PROGRA 2 experiment), *Icarus*, 190, 660-671, 2007.

[5] Szopa, C., Cernogora, G., Boufendi, L., Correia, J.J. and Coll, P., PAMPRE a dusty plasma experiment for Titans tholins production an study, Planet. Space Sci. Vol. 54, pp. 394-404, 2006.

[6] Kuga, M., Marty, B., and Marrocchi, Y., Origin of refractory organics in chondrites: an experimental study, Goldschmidt 2013, Aug 25-30, Florence, Italy, Mineralogical Magazine 77, 1519, 2013.

[7] Tissandier, L., Libourel, G., Robert, F., Gas-melt interactions and their bearing on chondrule formation, Meteor. & Planet. Sci. vol. 37, pp. 1377-1389, 2002.

[8] Johnson N.M., Cody G.D., Nuth J.A. Organics on Fe-silicate grains: potential mimicry of meteoritic processes? LPI XXXV conference, March 15-19 2004 1876.