Linear polarization of light scattered by cometary analogs: New samples

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Mixtures of silicates (Mg and Fe) with carbonaceous compounds (carbon and/or organics) are currently proposed as cometary analogs. The particles are fluffy aggregates of submicron-sized constituent grains and compact grains (tens of micrometers), similar to those captured in the Earth's stratosphere (interplanetary dust particles or IDPs) and deduced from the Stardust results. They are lifted or in microgravity or levitated by an air-draught. The light source is unpolarized. The linear polarization of the scattered light floating in the beam is studied as a function of the phase angle.

In previous experiments with the PROGRA2 instrument (Hadamcik et al., 2011), the general shape of the cometary polarimetric phase curves is reproduced with a shallow negative branch and a more developed positive branch (maximum polarization around 20–30 %) depending on the size distributions of the particles (compact and/or aggregates) and their constituent grains. To observe the increase of polarization with wavelength, the organic materials were necessary. When fluffy aggregates (silicates and carbon black mixtures) and compact silicate grains of tens of micrometers are present, the whole cometary coma polarization phase curve is well fitted by the phase curves obtained. The maximum polarization value decreases when the ratio of compact silicates to fluffy aggregates increases. The observed differences in polarization between different coma regions may be also simulated. When only fluffy aggregates are used, the maximum polarization corresponds to the polarization in jets of 'high polarization' active comets (Hadamcik and Levasseur-Regourd, 2003). A high polarization region may exist in some 'low polarization' comets, with large slowly moving particles; using the experimental results, we suggest the presence of dark relatively compact particles larger than 20 micrometers (Hadamcik et al., 2007; 2011).

When not hidden by jets, a polarimetric halo is sometimes observed in the inner coma. The negative branch can be as deep as -6% and the positive branch is smaller as compared to the whole coma (Hadamcik et al., 2003). Zubko et al. (2012) have proposed an increased fraction of silicates. From the experiments, we suggest some carbonaceous compounds with refractive indices close to those of silicates (relatively transparent). This material, if heated by the Sun after ejection, should be darker as observed when these materials are heated to 200–300°C. We are working on new analogs with mixtures of silicates and organics (not only carbon), silicates coated by organics (Johnson et al., 2004), or organics heated or not and with different elemental compositions (N/C ratios).

Acknowledgements: We acknowledge CNES and ESA for the microgravity flights.

References: Hadamcik E. and Levasseur-Regourd A.C., JQSRT 79–80, 661-678 (2003); Hadamcik E. and Levasseur-Regourd A.C, AandA 403, 757–768 (2003); Hadamcik E., Levasseur-Regourd A.C., Leroi V., Bardin D., Icarus 190, 459–468 (2007); Hadamcik E., Renard, J.-B., Levasseur-Regourd, A.C., and Lasue, J., (2011) In: Polarimetric detection, characterization, and remote sensing (Mishchenko, M.I., Yatskiv, Y.S., Rosenbush, V.K., Videen, G., Eds.), 137–175 NATO science for peace and security programme, Springer, Dordrecht; Johnson N.M., Cody G.D., Nuth J.A., LPI XXXV, 1876 (2004); Zubko et al., A&A 544, L8 (2012).