Texture analysis of IDPs and comparison to 67P dust particles

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The Interplanetary Dust Particles (IDPs) are collected in the Earth's stratosphere by NASA aircraft and curated at the Johnson Space Center. Approximately a third of those samples are determined to be of extra-terrestrial origin (either asteroidal or cometary) based on a composition close to the bulk composition of primitive carbonaceous chondrites (CV3, such as Allende) [1]. Automatic analysis of the particles composition has been shown to improve the classes and classification of the different samples [2]. Studies show the close relationship between IDPs and comets based on the fact that meteor shower dust streams are linked to cometary orbits, and that numerical dynamical models indicate most dust particles within 1 au from the Sun originate from cometary activity.
During the 2 years of the Rosetta mission at comet 67P/Churyumov-Gerasimenko, dust detection instruments have been probing the ejected dust properties. The GIADA, COSIMA and MIDAS instruments unveiled the existence of two populations of particles with very different properties (one with compact entities and one with agglomerates of many sub-units). The imaging of the COSIMA and MIDAS experiments renders possible the investigation of the agglomerate structure of dust particles with many bulbous sub-units at different size scales (from millimetres down to 100s of nanometres), [3, 4, 5], which is akin to the self-affine similarity found in fractals. In this work, we use texture analysis of the particles images (e.g. roughness, variograms, fractal dimension) in order to determine classes of IDPs that are relevant to their origin. We then compare the classification scheme to the results obtained from the image analysis of the Rosetta experiments. A simple model of fractal aggregate deformation is also developed to tentatively constrain to the first order the particles properties (e.g. dimension, density, tensile strength) before collection.

[1] Rietmeijer, F. J., Interplanetary Dust Particles in Planetary Materials, (Papike ed.), (Vol. 36). Mineralogical Society of Amer. (1998)
[2] Lasue, J., Stepinski, T., & Bell, S. W. (2010). Automated classification of interplanetary dust particles: Johnson Space Center Cosmic Dust Catalog Volume 15. Meteoritics & Planetary Science, 45(5), 783-797
[3] M.S. Bentley et al, Aggregate dust particles at comet 67P/Churyumov-Gerasimenko, Nature 537,73, 2016
[4] T. Mannel et al., Fractal cometary dust - a window into the early solar system, MNRAS 462, 2016
[5] Langevin et al. (2016). Typology of dust particles collected by the COSIMA mass spectrometer in the inner coma of 67P/Churyumov Gerasimenko. Icarus, 271, 76-97