Geophysical Research Abstracts
Vol. 21, EGU2019-17361, 2019
EGU General Assembly 2019

Cometary dust: structure at the nanometre scale

Thurid Mannel (1,2), Mark Bentley (3), Peter Boakes (1), Harald Jeszenszky (1), Pascale Ehrenfreund (4,5), Cecile Engrand (6), Christian Koeberl (7,8), Anny-Chantal Levasseur-Regourd (9), Jens Romstedt (10), Roland Schmied (1), Klaus Torkar (1), and Iris Weber (11)

(1) Space Research Institute of the Austrian Academy of Sciences, Graz, Austria (thurid.mannel@oeaw.ac.at)., (2) University of Graz, Universitätsplatz 3, 8010 Graz, Austria., (3) European Space Astronomy Centre, Camino Bajo del Castillo, s / n., Urb. Villafranca del Castillo, 28692 Villanueva de la Cañada, Madrid, Spain., (4) Leiden Observatory, Postbus 9513, 2300 RA Leiden, The Netherlands., (5) Space Policy Institute, George Washington University, 20052 Washington DC, USA., (6) Centre de Sciences Nucléaires et de Sciences de la Matière (CSNSM) CNRS-IN2P3 / Univ. Paris Sud, Université Paris-Saclay, Bât. 104, F-91405 Orsay Campus, France., (7) Department of Lithospheric Research, University of Vienna, Althanstrasse 14, 1090 Vienna, Austria., (8) Natural History Museum, Burgring 7, 1010 Vienna, Austria., (9) UPMC (Sorbonne Univ.), CNRS / INSU, LATMOS-IPSL, Paris, France., (10) European Space Research and Technology Centre, Future Missions Office (SREF), Noordwijk, The Netherlands., (11) Institut für Planetologie, Universität Münster, Wilhelm-Klemm-Strasse 10, 48149 Münster, Germany.

The Rosetta orbiter carried three dedicated dust analysis instruments to investigate the properties of the comet and its dust at smallest scales. The images with the highest resolutions were obtained by the MIDAS (Micro-Imaging Dust Analysis System) atomic force microscope [1,2]. It collected dust particles of one to tens of micrometres in size and imaged their surface in 3D. Nominal images had approximately hundreds of nanometres resolution and were used to study the particle morphology at the micrometre scale. It was shown that the majority of collected particles were fragile agglomerates [3] with a moderate packing density of subunits at the surface [4]. Exceptions were one extremely porous particle with a fractal structure that is suggested to be pristinely preserved from early agglomeration processes in our Solar System [4], and the particles of about one micrometre size that show less fragility. To study these smallest detected particles a special scanning mode, called 'reverse imaging mode', was developed that reached resolutions down to eight nanometres [5]. In the reverse imaging mode dust particles were picked up with the tip and imaged with the help of a sharp spike on a calibration sample. The resulting images opened the possibility to identify the agglomerate structure of the dust down to the nanometre scale and to determine smallest features with mean sizes of about 100 nanometres. Whether these smallest features are surface related or true subunits comprising the dust will be discussed on the basis of comparisons to smallest subunit sizes identified by indirect Rosetta measurements and by investigations of other cometary material.

References:

[1] W. Riedler, K. Torkar, H. Jeszenszky, et al., MIDAS – The Micro-Imaging Dust Analysis System for the Rosetta Mission. Space Science Reviews 128, 2007.

[2] M.S. Bentley, H. Arends, B. Butler, et al., MIDAS: Lessons learned from the first spaceborne atomic force microscope. Acta Astronautica 125, 2016.

[3] M.S. Bentley, R. Schmied, T. Mannel et al., Aggregate dust particles at comet 67P/Chruyumov-Gerasimenko, Nature, 537, 2016.

[4] T. Mannel, M.S. Bentley, R. Schmied et al., Fractal cometary dust – a window into the early Solar system, MNRAS, 462, 2016.

[5] T. Mannel, M.S. Bentley, P.D. Boakes, et al., MIDAS results: classification and extension to the nanometre scale, submitted to Astronomy & Astrophysics, Rosetta special issue, 2018.