A multi-instrument modelling perspective of cometary activity

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The determination of the activity distribution on the surface of a comet is a key goal of any mission to investigate the interaction of the comet with the Sun. As the ice sublimates the gas expands into space it fills the near-nucleus environment. Individual sources of activity have been observed on the surface but it remains uncertain where the bulk of the mass is lost and how the processes that are involved work in detail. There are several reasons for this. First, imaging experiments use the dust as a proxy for the gas activity. Because the optical depth of the dust is orders of magnitude below 1 in all but a few cases, it is not possible to trace dust filament back to the source against the backdrop of the illuminated surface. Second, remote sensing instruments detecting gas emission (i.e. infrared and sub-mm spectrometers) may suffer with limited spatial and temporal resolution. In addition, the spectra lines may be optically thick and the line-of-sight direction usually cuts through inhomogeneous coma (in density or temperature) which further complicates their interpretation considerably. The in-situ instruments (e.g. ROSINA, or GIADA) must consider possible biases due to the spacecraft position relative to the nucleus and respective illumination conditions on the surface. For instance, the frequent use of terminator orbits by Rosetta introduced a significant problem because the measured local densities are at points remote from what we assume to be the main direction of outflow, namely near the sunward direction. In addition, the possible inhomogeneities of the outgassing at the surface cannot be detected due to the fact that the rapid gas expansion smoothens the coma. Therefore, measurements taken tens of kilometers above the nucleus surface are rather insensitive and provide only ambiguous results.

The difficulties described above show the need for predictive models that can reproduce multiple measurements in one self-consistent framework. We will present results from our study of diverse Rosetta data sets (including OSIRIS, VIRTIS, MIRO, and ROSINA), constraining the gas emission into the coma and to establish whether the data enable us to reach appropriate conclusions on the activity distribution on the nucleus surface. The models can be used on the one hand to constrain certain properties of the activity and on the other hand they provide clues on the limits of the interpretations of some of the available datasets.

Acknowledgement
The team from the University of Bern is supported through the Swiss National Science Foundation, and through the NCCR PlanetS.
This project has received funding from the European Unions Horizon 2020 research and innovation programme under grant agreement No 686709 (MiARD project, www.miard.eu). This work was supported by the Swiss State Secretariat for Education, Research and Innovation (SERI) under contract number 16.0008-2. The opinions expressed and arguments employed herein do not necessarily reflect the official view of the Swiss Government.
OSIRIS was built by a consortium of the Max-Planck-Institut für Sonnensystemforschung in Göttingen, Germany; CISAS-University of Padova, Italy; the Laboratoire d'Astrophysique de Marseille, France; the Instituto de Astrofisica de Andalucia, CSIC, Granada, Spain; the Research and Scientific Support Department of the European Space Agency, Noordwijk, The Netherlands; the Instituto Nacional de Tecnica Aeroespacial, Madrid, Spain; the Universidad Politechnica de Madrid, Spain; the Department of Physics and Astronomy of Uppsala University, Sweden; and the Institut für Datentechnik und Kommunikationsnetze der Technischen Universität Braunschweig, Germany. The support of the national funding agencies of Germany (DLR), France (CNES), Italy (ASI), Spain (MEC), Sweden (SNSB), and the ESA Technical Directorate is gratefully acknowledged.
Work on ROSINA at the University of Bern was funded by the State of Bern, the Swiss National Science Foundation, and the ESA PRODEX Programme.