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A methodology for quantitatively estimating a distributed source of volatiles in a cometary coma

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Rosetta will rendez-vous with comet 67P/Churyumov-Gerasimenko in May 2014. One of its objectives is to study the gas in the cometary coma. The Rosetta Orbiter Spectrometer for Ion and Neutral Analysis (ROSINA) package aims to determine the gas composition in the coma, in particular during the planned close flyby episodes.

An outstanding question – since earlier findings by Giotto at 1P/Halley – is the role of outgassing from dust particles. The gas in the coma mainly originates from sublimation of volatiles on the nucleus surface, but additional sublimation from dust particles may contribute as well. The dust therefore provides a "distributed source" of such volatiles. In particular, outgassing from dust particles necessarily will lead to different radial profiles of the sublimated gas and/or its photo-dissociation products, and through chemical reactions it may affect many other species.

In the present contribution we demonstrate how information about the dust source can be inferred from the measured abundance of species in the coma, preferably over a range of distances from the nucleus. This is achieved by solving an inverse problem that is based on knowledge of the reaction pathways, the solar UV flux, and the coma measurements. The detailed characteristics of the distributed source depend on the dust grain size distribution, the outgassing rate, the possibly different composition of the volatile material carried by the grains, the dust grain outflow velocities, and dust grain fragmentation. The proposed methodology is limited in determining these characteristics, but it can be refined or constrained by incorporating information, for instance, provided by the dust instruments on board Rosetta.