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3-D Simulations of the Inner Dust Comae for Comet 67P/Churyumov-Gerasimenko

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The aims of this study are to (1) model the gas flow-field in the innermost coma for a plausible activity distributions of ROSETTA's target comet 67P/Churyumov-Gerasimenko (67P) using the SHAP2 model, (2) compare this with the ROSINA/COPS gas density (3) investigate the acceleration of dust by gas drag and the resulting dust distribution, (4) produce artificial images of the dust coma brightness as seen from different viewing geometries for a range of heliocentric distances and (5) compare the artificial images quantitatively with observations by the OSIRIS imaging system.

We calculate the dust distribution in the coma within the first ten kilometers of the nucleus by assuming the dust to be spherical test particles in the gas field without any back coupling. The motion of the dust is driven by the drag force resulting from the gas flow. We assume a quadratic drag force with a velocity and temperature-dependent drag coefficient. The gravitational force of a point nucleus on the dust is also taken into account which will e.g. determine the maximal liftable size of the dust. Surface cohesion is not included.

40 dust sizes in the range between 8 nm and 0.3 mm are considered. For every dust size the dust densities and velocities are calculated by tracking around one million simulation particles in the gas field. We assume the distribution of dust according to size follows a power law, specifically the number of particles n or a particular radius r is specified by $n \sim r^{-\beta}$ with usual values of $3 \leq \beta \leq 4$ where $\beta = 3$ corresponds to the case of equal mass per size and $\beta = 4$ to a shift of the mass towards the small particles.

For the comparison with images of the high resolution camera OSIRIS on board ESAs ROSETTA spacecraft the viewing geometry of the camera can be specified and a line of sight integration through the dust density is performed. By means of Mie scattering on the particles the dust brightness can be determined.

A variety of dust size distributions, gas to dust mass ratios, wavelengths and optical properties can thus be studied and compared with the data.