# The Near-Nucleus Dusty Gas Coma of Comet 67P/Churyumov-Gerasimenko Prior to the Descent of The Surface Lander PHILAE

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We describe the RZC model developed to predict the neutral gas environment of comet 67P/Churyumov-Gerasimenko and the results of adjustment of this model to the observational data obtained before lander delivery by the Rosetta Orbiter Spectrometer for Ion and Neutral Analysis (ROSINA). Also, we present the results of our attempts to fit the dust coma images obtained by the Optical, Spectroscopic, and Infrared Remote Imaging System (OSIRIS).

The RZC model for gas environment consists of two components: (1) a numerical 3D+t code solving the Eulerian/Navier-Stokes equations governing the gas outflow, and a DSMC gaskinetic code with the same objective. And (2) an iterative procedure to adjust the assumed model parameters to best-fit the observational data at all times.

For the dust coma we use the stochastic approach - the Dust Monte-Carlo (DMC). We assume that dust grains are spherical moving under the influence of three forces: the nucleus gravitational force, gas coma aerodynamic force, and solar radiation pressure force, and consider the full mass range of ejectable grains. The dust grains move slower than the gas, therefore for the dust coma we perform fully time-dependent simulations.

Ideally, the optimization of the gas model would have resulted from a succession of predictions of the local gas parameters along optimal probe trajectories, as well as of the gas parameters inside the field-of-view of the remote sensing instruments, followed by comparison with the in-situ sampling and remote sensing instrument data. However, this turned out to be impossible for many reasons. Instead, preset trajectories and instrument view directions were defined which then may not have been optimal to derive the complex neutral gas environment of the comet. Therefore, in our first approach, we are limiting our efforts to fit the ROSINA gas measurements. Also, since cometary dust has been shown to be an accurate tracer of the gas flow discontinuities, we made attempts to fit the dust coma images of OSIRIS.

We demonstrate that our model is able to reproduce the overall features of the local neutral number density and composition measurements of the ROSINA COPS and DFMS instruments in the period August 1 – November 30 of 2014. The results of numerical simulations show that illumination conditions on the nucleus are the main driver for the gas activity of the comet. We present the distribution of surface inhomogeneity best fitted to the ROSINA in-situ measurements.