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3D DSMC Modeling of the Coma of Comet 67P/Churyumov-Gerasimenko Observed by the VIRTIS and ROSINA instruments

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1. Introduction

Since its rendez-vous with comet 67P/Chruryumov-Gerasimenko (CG), the Rosetta spacecraft has provided invaluable information contributing to our understanding of the cometary environment. On board, the VIRTIS and ROSINA instruments can both measure gas parameters in the rarefied cometary atmosphere, the coma, and provide complementary results with remote sensing and in-situ measurements, respectively.

The use of a numerical model is a way to correlate the information provided by both VIRTIS and ROSINA to fully understand the volatile environment of comet CG. To describe the entire coma including the regions where collisions cannot maintain the flow in a fluid regime, the use of a kinetic method is necessary. Here, the Direct Simulation Monte-Carlo (DSMC) approach is applied to the cometary coma to solve the Boltzmann equation [1] using the Adaptive Mesh Particle Simulator (AMPS) code [2], [3], [4], [5], and then compared with VIRTIS and ROSINA data.

2. Description of the model

During its journey in the Solar System, as the comet gets within a few astronomical units of the Sun, solar heating liberates gases and dust from its icy nucleus forming the coma. The model boundary conditions are then based on the local solar illumination. The complex shape of the nucleus of comet CG, here based on SHAP5 from the OSIRIS team, requires taking into account self-shadowing. The temperature at the inner boundary is based on the thermophysical model from [6], [7], [8], while the gas flux is constrained by ROSINA measurements and driven by the angle between the normal of each surface element with the solar direction. This model was shown to have a good agreement with both ROSINA [9] and VIRTIS-H [10] data. Progress comparing the model with VIRTIS and ROSINA data is described. This comparison provides a better global understanding of the gas coma of comet CG.

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