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Gas flow in the near-surface porous boundary layer of the 67P/Churyumov-Gerasimenko using micro-CT images

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While ESA's Rosetta mission has formally been completed, the data analysis and interpretation continues. Here, we address the physics of the gas flow at the surface of the comet. Understanding the sublimation of ice at the surface of the nucleus provides the initial boundary condition for studying the inner coma. The gas flow at the surface of the comet 67P/Churyumov-Gerasimenko can be in the rarefaction regime and a non-Maxwellian velocity distribution may be present. In these cases, continuum methods like Navier-Stokes-Fourier (NSF) set of equations are rarely applicable. Discrete particle methods such as Direct Simulation Monte Carlo (DSMC) method are usually adopted. DSMC is currently the dominant numerical method to study rarefied gas flows. It has been widely used to study cometary outflow over past years .[1,2]. In the present study, we investigate numerically, gas transport near the surface of the nucleus using DSMC. We focus on the outgassing from the near surface boundary layer into the vacuum (~20 cm above the nucleus surface). Simulations are performed using the open source code *dsmcFoam* on an unstructured grid. Until now, artificially generated random porous media formed by packed spheres have been used to represent the comet surface boundary layer structure .[3]. In the present work, we used instead Micro-computerized-tomography (micro-CT) scanned images to provide geologically realistic 3D representations of the boundary layer porous structure. The images are from earth basins. The resolution is relatively high - in the range of some μm. Simulations from different rock samples with high porosity (and comparable to those expected at 67P) are compared. Gas properties near the surface boundary layer are presented and characterized. We have identified effects of the various porous structure properties on the gas flow fields. Temperature, density and velocity profiles have also been analyzed.

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