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Quasi 3-D thermal evolution models of comet nuclei: the ROSETTA target 67P/CHURYUMOV-GERASIMENKO.

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Rosetta's main objective is to rendezvous with comet 67P/Churyumov-Gerasimenko. It will study the nucleus of the comet and its environment. Here we will present the results of a new quasi three-dimensional approach for non-spherically shaped cometary nuclei, which has been developed to interpret the current activity of comets in terms of initial characteristics, and to predict shape and internal stratification evolution of the nucleus. We applied this model to comet 67P/Churyumov-Gerasimenko. The shape of the comet can be described in our model through a two-dimensional discreet grid defined with the angles [U+F071] and [U+F06A] corresponding to the latitude and longitude of the points considered on the comet. Each global shape (spherical, ellipsoidal, spherical harmonics) defined can be altered by the presence of crater-like depressions. For each shape or altered shape, the shadow of each point on the surface of the nucleus is calculated. The thermal evolutions are calculated locally, using as input the solar illumination and the different parameters of the cometary material beneath the surface. The numerical code computes the heat diffusion in the porous cometary material, leading to the water ice phase transition and the sublimation of the volatile ices. The initially homogeneous nucleus differentiates, exhibiting a layered structure, in which the boundary between different layers is a sublimation front. The model takes into account the amorphous-crystalline transition with the release of gases trapped in the amorphous ice, if any. The gases diffuse inside the pore system, either re-condensing in the colder layers or else escaping into space. The gas flux is computed according to the kinetic theory. When the ices begin to sublimate, refractory particles are liberated subject to the drag exerted by the escaping gas, so that some are either blown off or accumulate on the surface to form a crust. Surface erosion due to ice sublimation, particles ejection, crust formation and compaction is computed at each step.

Calculations have been done for different shaped nuclei. Each shape can have with different obliquities and can be altered with crater-like depressions.

Our calculations have shown that local variations in the dust and gas fluxes can be induced by the illumination conditions on the nucleus shape. The fluxes actually lead to the erosion of the comet nucleus and will thus modify the characteristics of the nucleus. The most volatile ice, like CO, are less influenced by the nucleus shape and obliquity, while water flux is strongly dependent from the illumination condition. The water comes from illuminated regions of the comet and follows the day/night illumination variations and the seasonal illumination variations. These seasonal effects can be seen the activity behaviour and flux and dust distribution patterns.