THERMAL EVOLUTION OF NON-SPHERICAL COMET NUCLEI.
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Introduction: Numerical models of cometary evolution have been developed during the last two decades. Initial models used a one-dimensional representation of an ideal spherical nucleus while the last models take into account both the latitudinal and the longitudinal variations of illumination [1], [2], [3], [4], [5]. The recent in situ measurements of cometary nuclei have shown typical non-spherical shape and particular topography. Here we will present a new approach for non-spherically shaped cometary nuclei, which has been developed to interpret the activity of comets, their characteristics and internal properties.

Comet shapes: The cometary nuclei observed by the recent missions show non-spherical shapes and present various surface features. In our model, the shape of the comet can be described by a two-dimensional discreet grid defined with the angles θ and φ corresponding to the latitude and longitude of the points considered on the comet surface. The surface is defined by several facets. Spheroid shapes are defined by their three principal axes. Spherical harmonics functions calculated over the surface of the comet can be defined and used to calculate the illumination, and consequently, the thermal evolution of specific nuclei. Each global shape thus defined can be altered by the presence of a crater-like depression. For each shape, the shadow of each point on the surface of the nucleus is calculated by determining whether the direction to the Sun from the point considered crosses another part of the nucleus or not.

Thermal evolutions: Our numerical simulations make the assumption that the lateral heat transfer is negligible with respect to the normal heat transfer. For for each of the facets on the comet nucleus surface we calculate the thermal evolution, using as input the solar illumination and the different parameters of the cometary material beneath the surface. The model used for these simulations has been fully described in previous works [1], [3], [5]. The nucleus is composed by dust and different ices (H2O, CO, CO2, etc.). 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. 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 dust crust. Surface erosion due to ice sublimation, particles ejection, dust crust formation and compaction is computed at each step. For further details, see previous articles ([1], [3], [5]).

Results for different comet nuclei shapes: Calculations have been done for spherical nuclei with different obliquities, spherical nuclei with crater-like depressions and spheroid-shaped nuclei. Here we will brefly see the differences between a spherical shapes with or without a crater-like depression. The calculations are made through the multistage injection orbits and three orbits close to the Sun (a= 3.84, e=0.43). Our calculations have shown that local variations in the dust and gas fluxes can be induced by the nucleus shape. The presence of crater-like depressions or spheroidal deformations can induce a diurnal asymmetry of the comet activity. Specifically, crater-like depressions present on the surface modify the diurnal flux of the comet and can decrease its global flux, especially at the aphelion, creating variations in the activity of the comet. We have seen also that crater-like depressions can be erased within the lifetime of the comet and may in part explain the flat-bottomed depressions observed at the surface of cometary nuclei. Our code allows for the calculations of very different shaped nuclei. Further studies will be applied to the case of specific comets with longer and detailed simulation.

References: [1] Capria et al. (2001), *Planet. Space Sci. 49*, 907-918. [2] Cohen et al. (2003) *New Astronomy 8*, 179-189. [3] De Sanctis et al. (2005) *Astron. Astrophys. 444,* 605-614. [4] Sarid et al. (2005) *Publ. Astronomical Society of the Pacific 117*, 796-809. [5] De Sanctis et al., (2007), *Astron. J. 133*, 1836-1846.