Dust Mantle Formation and Thermal Evolution of Comet Nuclei using a 3-D Numerical Model.

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We present a fully 3-D thermal evolution model for comet nuclei (Rosenberg and Prialnik [1]). The model uses an implicit numerical scheme in spherical coordinates. It includes heat flow, crystallization of amorphous ice, surface and sub surface sublimation of volatiles and drag of dust particles. The model is applied to a Jupiter-family comet and to a main-belt comet.

Comet 67P/Churyumov-Gerasimenko

Spacecraft observations of comet nuclei at close range have revealed dust covered surfaces with eventual patches of exposed ice (e.g., A'Hearn et al. [2]). Despite the insulating dust mantle, cometary activity appears to be closely correlated with heliocentric distance, and even with the daily local position of the sun. This indicates that the dust mantle must be thin and probably frequently regenerated. The question of the dust mantle thickness is of utmost importance for comet 67P/Churyumov-Gerasimenko, the target of the *Rosetta* mission.

We adopt the orbital and spin parameters of the comet in order to investigate in detail dust mantle formation on the surface of the nucleus. The effect of different processes and thermal conductivity values is estimated. We find a strong dependence of the dust mantle thickness on thermal conductivity.

Comet 133P/Elst-Pizarro

Recent observations have revealed a new class of objects in the asteroid belt (Hsieh and Jewitt [3]), which have orbits that are indistinguishable from those of asteroids. These objects have, however, the physical characteristics of comets, being active for several weeks to months on each orbit around perihelion and exhibiting dust tails. This suggests that the activity is driven by dust dragged from the surface by sublimating volatiles, as in the case of comets. They have thus been identified as *main-belt comets* (MBCs).

Since water ice, and certainly more volatile species, cannot survive for long periods of time on or near the surface of objects so close to the sun, it is more likely to find ice buried at some depth below the surface. Here we adopt the orbital and spin parameters of MBC 133P/Elst-Pizarro in order to investigate its activity on the assumption that deeply buried ice has been exposed at the surface by an impact. We test both homogeneous and inhomogeneous initial structures.

References

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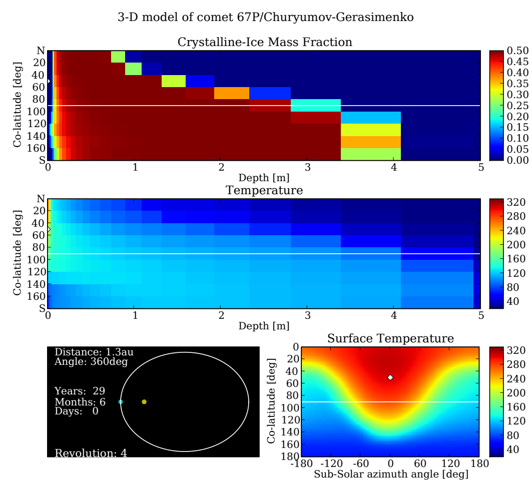

Figure 1: Dust mantle and crystallization front for comet nucleus 67P/Churyumov-Gerasimenko after 4 orbital revolutions. Crystalline mass fraction (top), internal temperature (middle), and surface temperature (bottom right) are presented for perihelion.