THERMAI . MO DELING OF SHORT-PERIOD COMETS: EFFECTS OF OBLIQUITY

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A thermal model for short-period comets has been developed, based on the comet nucleus model of Weissman and Kieffer (Icarus 47, 302, 1981). As an example, the model is applied to periodic Comet Kopff, and estimates the surface temperature distribution and sublimation rate on a rotating icy sphere in heliocentric orbit. Assumed parameters for Comet Kopff arc: nucleus radius = 4 km, surface albedo =- 0.04, surface density = 0.5 g cm^{-3}, rotation period = 10 hours, and surface thermal inertia = 0.003 cal $cm^{-2} s^{-1/2}$ K-'. Comparing the model results with observed gas production rates from Kopff in 1983, it is found that -1 5% of the sunlit nucleus surface is active, a relatively high fraction for a typical short-period comet. This suggests that the actual nucleus radius may be larger than the model value, The slope of the observed gas production curve with heliocentric distance is steeper than that predicted by the thermal model. This may indicate the existence of a more complex process than direct sublimation of surface ices, or may be a result of the orientation of the Kopff rotation axis, which is currently unknown,

If onc assumes a nucleus obliquity near zero, then the resulting estimated sublimation rates pre- and post-perihelion arc remarkably symmetric, suggesting that any observed asymmetries are the result of the distribution of active areas on the nucleus surface of Comet Kopff. On the other hand, if large obliquities arc assumed, then pre- and post-perihelion gas production rates can vary accordingly. However, the greatest variation in gas production rate for high obliquities comes at large heliocentric distances, beyond 2.5 AU. Variations by orders of magnitude arc possible. This is because the energy going into sublimation at large distances is comparable to the surface heat flow and reradiation terms. Nearer to perihelion virtually all energy goes into sublimation and nucleus orientation becomes a less significant factor. An example of the predicted gas production versus heliocentric for comet Kopff is shown below.

The model results have important implications for the upcoming Rosetta mission, since they demonstrate that short-period comets may exhibit greater than expected activity at relatively large solar distances, depending on nucleus obliquity and other currently unknown quantities for the proposed Rosetta targets. This work was supported by the NASA Planetary Geology and Geophysics Program.

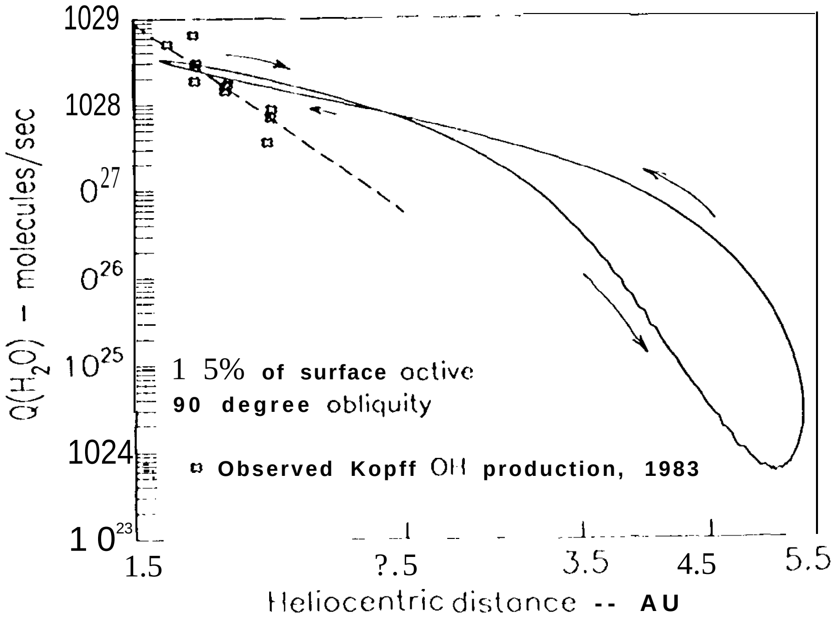

Figure 1. Predicted water production versus heliocentric distance for an icy sphere in the orbit of cornet Kopff, assuming 1 50/0 of the surface area being active and an obliquity of 90°. The model prediction is compared with observations of OI] production from comet Kopff in 1983.