N91-26007

RANDOMIZATION OF PARTICLE MOTIONS AND THE OBSERVED MORPHOLOGY OF COMETARY HEADS. *Zdenek Sekanina*, Jet Propulsion Laboratory, California Institute of Technology

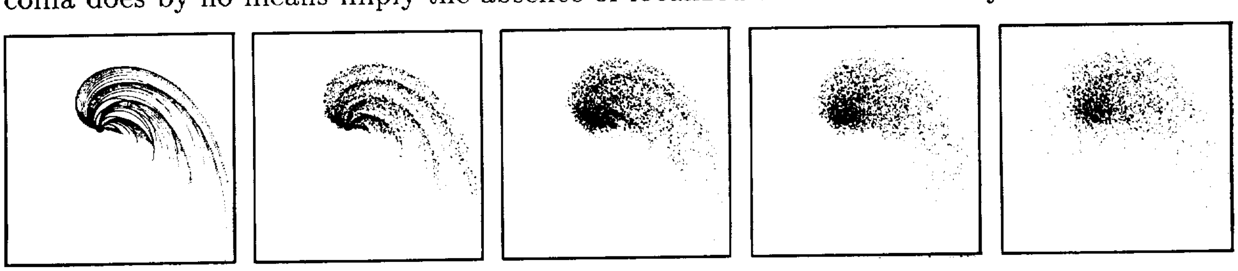
A great diversity is known to exist in the coma morphology of comets. In particular, some comets show much structural detail in their heads (such as jets, halos, fans, plumes, streamers), while others have completely structureless comas. Obvious questions arise as to why is this so and what does the presence or absence of features tell us about the emission processes on cometary nuclei. In an effort to investigate these problems, I have modified a computer code that generates synthetic images of dust comets by introducing random perturbations into motions of ejected particles. The perturbed rectangular cometocentric coordinates ξ', η', and ζ' of any dust grain in the coma have been written in the form

$$\begin{pmatrix} \xi' \\ \eta' \\ \zeta' \end{pmatrix} = \begin{pmatrix} \xi \\ \eta \\ \zeta \end{pmatrix} + \sum_{i=1}^{2} \alpha_i \, \rho^{i-1} c_i \, \mathcal{R}_{i\alpha} \begin{pmatrix} \cos(2\pi \mathcal{R}_{i\theta}) \sin(\pi \mathcal{R}_{i\phi}) \\ \sin(2\pi \mathcal{R}_{i\theta}) \sin(\pi \mathcal{R}_{i\phi}) \\ \cos(\pi \mathcal{R}_{i\phi}) \end{pmatrix},$$

where ξ, η, and ζ define the grain's unperturbed position, α_1 and α_2 are the parameters of random perturbations that, respectively, are independent of the grain's length of residence $\rho = (\xi^2 + \eta^2 + \zeta^2)^{1/2}$ and vary as ρ, c_i are normalizing constants, and $\mathcal{R}_{i\alpha}$, $\mathcal{R}_{i\theta}$, and $\mathcal{R}_{i\phi}$ are random numbers $[\mathcal{R}_{i\alpha} \in (0, \infty), \{\mathcal{R}_{i\theta}, \mathcal{R}_{i\phi}\} \in (0,1)]$ that satisfy the following conditions:

$$\mathcal{R}_{i\alpha} = (\ln 2)^{-1} \ln \frac{1}{1-\mathcal{R}}, \qquad \mathcal{R}_{i\theta} = \mathcal{R}, \qquad \mathcal{R}_{i\phi} = \arcsin(2\mathcal{R} - 1)/\pi + \tfrac{1}{2},$$

where $\mathcal{R}$ is a random number from a set arranged uniformly over the interval of (0,1). These formulas generate spherically symmetrical distributions of perturbation vectors centered on the unperturbed positions in such a manner that equal numbers of grains are located at distances smaller and greater than $\alpha_1 c_1$ or $\alpha_2 \rho c_2$. An example below illustrates expected effects of variable perturbations exerted on dust motions in the coma. The circumstances of ejection are identical for all five images, the image on the far left representing the grains' unperturbed positions. It is noted that the introduction of perturbations has made the computer generated images simulate the appearance of comets quite faithfully and that by increasing the perturbations beyond a certain limit it has been possible to "erase" the coma morphology diagnostic of the details of the ejection process. It is proposed that the degree of collimation of an ejecta flow from discrete active sources on the nucleus surface and possible emissions of dust from the rest of the nucleus directly affect the sharpness of features observed in the dust coma. Molecules of comet gases that radiate in the spectral region employed (and whose velocity distribution is much more chaotic than that of dust particles) and limited atmospheric seeing likewise contribute to blurring structural detail in ground-based imaging observations of comets. The absence of discrete features in the coma does by no means imply the absence of localized sources of activity on the nucleus.



$\alpha_1 = 0,\ \alpha_2 = 0$ $\qquad$ $\alpha_1 = \frac{1}{2},\ \alpha_2 = \frac{1}{2}$ $\qquad$ $\alpha_1 = 2,\ \alpha_2 = 2$ $\qquad$ $\alpha_1 = 2,\ \alpha_2 = 10$ $\qquad$ $\alpha_1 = 10,\ \alpha_2 = 2$