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How large cometary dust grains are?

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Abstract

Every dust grain of a cometary nucleus surface suffers the action of several forces: drag force, nucleus and Sun gravitational forces, solar radiation pressure force and inertial forces. The latter forces, due to the nucleus-attached selected system, are the gravitational comet attraction by the Sun and that due to the rotation of the comet (spin). The rotational inertial force can be expressed by

$$\frac{4}{3}\pi\left(\frac{d}{2}\right)^3 \rho_d [\Omega^2 \cdot \vec{r}_d - (\vec{\Omega}\cdot\vec{r}_d)\cdot\vec{\Omega} + 2\vec{v}_d \times \vec{\Omega}]$$

where d is the dust grain diameter, ρ_d is the grain density, $\vec{\Omega}$ is the nucleus angular velocity, and $\vec{r}_d$ and $\vec{v}_d$ are the dust grain position vector and the speed, respectively. As noted by [1], dust grains will lift from the nucleus if $\sum \vec{F_i}.\vec{n} > 0$, being $\vec{n}$ an unit normal vector to the surface. In the limit, that scalar product will be equal to 0 for the largest grain that can be lifted from the nucleus, noted here by d_{max} (maximum diameter).Thus, we obtain:

$$d_{\max} = \frac{1}{\rho_d g_{eff}} \frac{3C_D \dot{m}_g v_g}{16\pi^2 R^2}$$, being $g_{eff} = g - \Omega^2 R \sin^2\varphi$

(g is the gravitational acceleration of the comet and φ is the latitude of the surface place where the dust particle is left). The rotation term can be important, as reported by [2] and so for comets rotating as fast as a six hours period, the obtained value of $d_{\max}$ increases by more than 40 per cent.

In this work we discuss the obtained values of $d_{\max}$ for comets studied using different techniques. We will also show orbits of dust particles released from the nucleus surface and we will compare with those obtained by [3].

References

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