

MIGRATION OF DUST PARTICLES FROM COMET 2P ENCKE. S.I. Ipatov, *George Mason University, USA; Institute of Applied Mathematics Moscow; siipatov@hotmail.com*, J. C. Mather, *NASA/GSFC, USA*.

Table 1: Values of P_r , T and T_l (in Kyr) (Venus=V, Earth=E, Mars=M)

β	Δt_o		V	E	E	M	T_l
			P_r	P_r	T	P_r	
0.002	0	S	470	200	94.6	12	551
0.002	0	L	632	208	93.6	14	370
0.004	0	S	370	148	62.9	8.9	213
0.004	0.25	S	430	160	55.0	9.3	109
0.004	0.5	S	235	140	56.3	8.1	108
0.01	0	S	191	105	25.1	5.4	67
0.01	0	L	386	163	28.5	6.4	80
0.01	0.25	S	238	86	24.2	4.2	59
0.01	0.5	S	123	56	22.6	3.8	49
0.05	0	S	120	59	9.3	5.7	1070
0.05	0	L	142	67	7.8	2.9	86
0.05	0.25	S	37	20	4.6	1.6	5
0.05	0.5	S	96	37	6.4	2.3	21
0.1	0	L	23	9.1	6.1	0.6	229
0.1	0.25	S	22	8.6	2.8	0.6	3
0.1	0.5	S	13	6.6	2.7	0.47	3
0.4	0.25	S	24	4.3	1.3	0.32	2
0.4	0.5	S	13	3.5	1.4	0.22	2

We investigated the migration of dust particles under the gravitational influence of all planets (except for Pluto), radiation pressure, Poynting–Robertson drag and solar wind drag for β equal to 0.002, 0.004, 0.01, 0.05, 0.1, 0.2, and 0.4. For silicate particles such values of β correspond to diameters equal to about 200, 100, 40, 9, 4, 2, and 1 microns, respectively. We used the Bulirsh–Stoer method of integration, and the relative error per integration step was taken to be less than 10^{-8} . Initial orbits of the particles were close to the orbit of Comet 2P Encke. We considered initial particles near perihelion (runs denoted as $\Delta t_o = 0$), near aphelion ($\Delta t_o = 0.5$), and also studied their initial positions when the comet moved for $P_a/4$ after perihelion passage (such runs are denoted as $\Delta t_o = 0.25$), where P_a is the period of the comet. Variations in time τ when perihelion was passed was varied with a step 0.1 day for series 'S' and with a step 1 day for series 'L'. For each β we considered $N = 101$ particles for "S" runs and 150 particles for "L" runs.

In our runs planets were considered as material points, but, basing on orbital elements obtained with a step 20 yr, similar to [1] we calculated the mean probability $P = P_\Sigma / N$ (P_Σ is the probability for all N considered particles) of a collision of a particle with a planet and the mean time $T = T_\Sigma / N$ during which perihelion distance q of a particle was less than a semi-major axis of the planet. For considered cometary dust particles, the values of T were not differed much for Venus, Earth, and Mars, but they differed by a factor of several for asteroidal dust particles [2].

Below $P_r = 10^6 P$ and T_l is the largest lifetime of a particle in series of runs. We studied the motion of particles until the last particle collided with the Sun or reached 2000 AU from the Sun. The results obtained are presented in Table

1.

All particles collided with the Sun at $\beta \leq 0.01$ for $\Delta t_o = 0$, and at $\beta \leq 0.2$ for $\Delta t_o \geq 0.25$. Relatively large values of T_l for 'S' runs at $\beta = 0.05$ and $\Delta t_o = 0$ and for 'L' runs at $\beta = 0.1$ and $\Delta t_o = 0$ were due to the particles that reached 2000 AU from the Sun.

The values of P_r , T , and T_l are greater for greater particles (i.e., for smaller β). The values of P_r are greater for Venus by a factor of 2 than those for Earth, and sometimes this difference was even greater. Collision probabilities with Earth were greater by a factor of 10-20 than those with Mars. They were greater for particles starting at perihelion than those starting at aphelion.

For the same values of β , the collision probabilities of dust particles with the terrestrial planets were smaller by a factor of several for considered comet particles than for asteroidal dust particles [2]. This difference is mainly due to greater eccentricities and inclinations of cometary particles.

The ratio of total times spent by cometary particles in inner-Earth ($Q = a(1 + e) < 0.983$ AU), Aten ($a < 1$ AU, $Q > 0.983$ AU), and Apollo ($a > 1$ AU, $q = a(1 - e) < 1.017$ AU) orbits was about 1.5 : 1 : 2, but it was different for different runs.

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References: [1] Ipatov S. I. and Mather J. C. (2003) *Advances in Space Research*, in press (<http://arXiv.org/format/astro-ph/0212177>). [2] Ipatov S. I., Mather J. C., and Taylor P.A. (2003) *Proc. of the intern. conference "New trends in astrodynamics and applications"* (20-22 January 2003, University of Maryland, in press (<http://arXiv.org/format/astro-ph/0303398>)).