DUST TORUS DEVELOPMENT AROUND MARS

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Small dust grains are continuously ejected from the surface of Phobos and Deimos by interplanetary particle bombardment. Recent studies (prompted in part by the Phobos 2 plasma and magnetic field measurements) have attempted to describe the expected dust grain halo comprised of these small dust particles [1, 2, 3, 4]. The torus density will be determined by the dust grain production and loss rates and is usually approximated analytically using a simple power law distribution. However, much of the dynamics and structure of the torus must be obtained using detailed orbital dynamics.

The current work models a system consisting of a Mars type planet along with two moons representing Phobos and Deimos in orbit around a Sun type star. The usual gravitational forces are taken into account (including the J_2 component of the Martian gravity) as well as the solar radiation force. Dust grains with radii varying between 100 μm to 5 μm are injected into the system and their orbital trajectories tracked. Several different numerical methods (3rd, 4th & 5th order Runga-Kutta) have been employed in an attempt to optimize CPU time constraints with numerical accuracy. The acceleration to the particle due to gravitational forces (excluding the J_2 component of the Martian gravity for the moment) is given by

$$\ddot{x}_i = \sum_{\substack{k=1 \\ k \neq i}}^{n-1} G m_k \left(\frac{x_k - x_i}{|x_k - x_i|^3} - \frac{x_k}{|x_k|^3} \right) - G(m_n + m_i) \frac{x_i}{|x_i|^3}$$

where that due to the radiation forces is

$$\ddot{\bar{x}} = \left(\frac{GM_s \beta}{r^2} \right) \left[\left(1 - \frac{\dot{r}}{c} \right) \hat{u}_r - \frac{\bar{v}}{c} \right]$$

where $\dot{r}$ is the radial velocity, $\hat{u}_r$ is the direction to the Sun, c is the speed of light, β is the ratio of radiation force to gravitational force, G is the gravitational constant and M represents the mass of the Sun [5]. Calculations were made with dust particles of varying radii, densities of 3 g/cm^3 and varying β values.

Several interesting results have been obtained and are illustrated below in Figures 1 - 4. Additional results (as well as a detailed analysis) will be presented in a forthcoming publication.

References: [1] Juhasz, A. and Horanyi M. (1995) JGR, 100, E2, 3277-3284.

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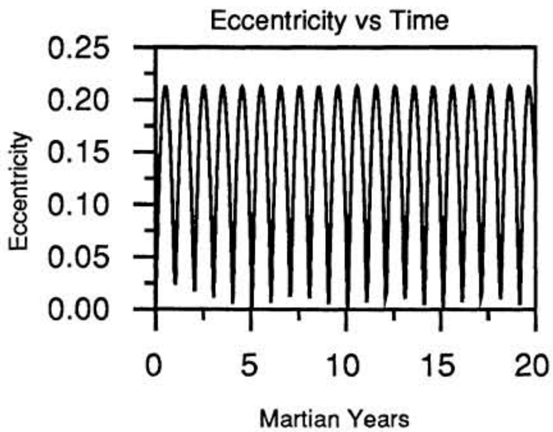

Fig. 1. The eccentricity of a 50 μm particle released along the orbit of Deimos and under the influence of the gravity of Mars and solar radiation pressure. The particle was tracked for 20 Martian years

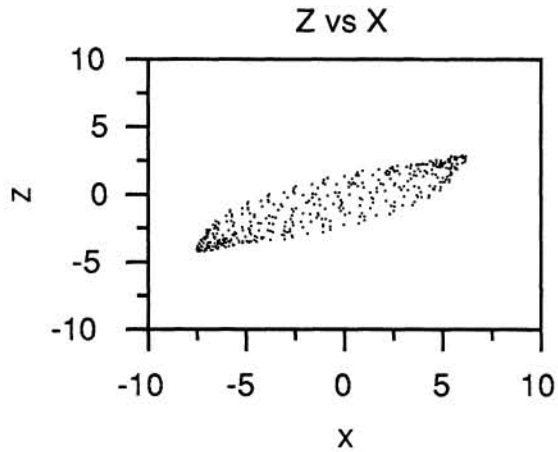

Fig. 2. A position plot of the same particle as in figure 1 in the X-Z plane. Z is the distance above the ecliptic plane defined by the orbit of Mars.

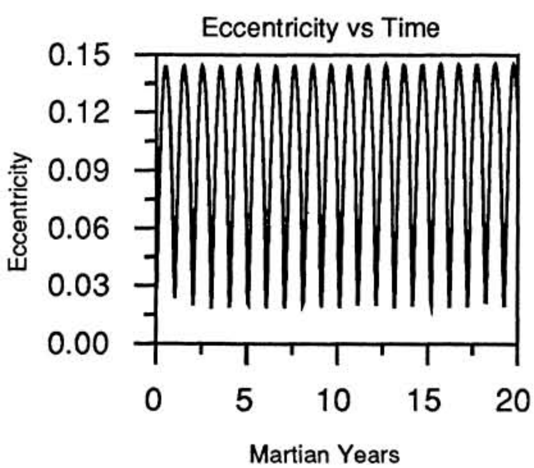

Fig. 3. The eccentricity of a 50 μm particle released from the orbit of Phobos and tracked for 20 Martian years. Only Martian Gravity and solar radiation pressure act on the particle.

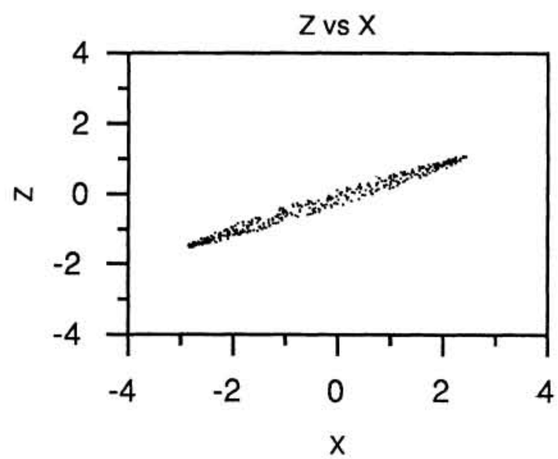

Fig. 4. The particle's cross-section in the X-Z plane. The conditions are the same as in Figure 3.

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