CONCENTRATION OF PHOBOS-DERIVED PARTICLES ON THE EQUATORIAL REGION OF MARTIAN SURFACE. Sho Sasaki (Planetary Sciences Group, Geological Institute, University of Tokyo, Hongo, Tokyo 113-0033, JAPAN, sho@geol.s.u-tokyo.ac.jp)

External Dust Source: Like other planets, Martian surface receives flux of interplanetary dust particles (micrometeorites) continuously. Michelangeli et al. included this flux to investigate the formation of Martian water clouds [1]. However, continuous supply of satellite-derived solid particles on planets has not been discussed, although contamination of Neptune's atmosphere by atomic or ionic nitrogen from Triton was proposed [2]. On the Earth, there found lunar meteorites but dust particles of lunar origin have not been detected precisely. Because of chemical similarity between the Earth and the moon, it is difficult to identify them. Phobos and Deimos are possibly trapped asteroids and of different chemical composition from Mars. Although interpretation of Phobos' reflectance spectrum is still in debate, there is an opinion that Phobos is in C-type category. Phobos-derived particles, if existed, could be identified in Martian surface samples. In the present study, from theoretical investigation of a dust ring around Mars, possible concentration of Phobos-derived particles on the Martian equatorial region is proposed.

Martian Dust ring: A dust ring around Mars was first advocated by Soter [3]. Mars has two small satelites (Phobos and Deimos) whose ejecta can easily escape because of low escape velocity (~10m/s). From 1990's, a number of theoretical works have been done on dynamical nature of dust ring/torus around Mars [4-15]. However, there have been no direct measurements of dust around Mars. Analysis of Viking Orbiter image data suggested no dust rings whose optical depth is larger than $3x10^{-5}$ [16]. Plasma measurements by PHOBOS-2 ASPERA showed indirect evidence of submicron dust at Phobos' orbit [17]. Now Japanese Mars mission NOZOMI has dust detector whose main purpose is to discover Martian dust ring [18]. It will start measuring Martian environment from 2004.

Theoretical Estimate of Dust Distribution: Submicron particles emitted from satellites are easily charged and scattered by solar wind magnetic field [5]. They are quickly captured with Mars. Orbits of particles larger than 1micron are controlled by solar radiation pressure and Martian oblateness [4, 8, 10, 12, 15]. Amplitude of eccentricity depends on the dust radius, r, through the optical parameter of a particle, b, ratio of radiation force to the solar gravity. As for particles from Phobos, e is largely enhanced when $r <$ 220micron. When $r <$ 22micron, particles are quickly captured with Mars [15]. Particles between 22 and 220 micron would form a thin dust ring around Mars (Fig. 1). Inclination of those particles are not changed largely.

Self-Sustaining Mechanism: A self-sustain mechanism was proposed to maintain the dust abundance. Collision of a ring particle with a satellite may produce additional ejecta which should contribute to the ring. Satellite-dust collision should be a dust supply process rather than a dust loss process. If dust production efficiency η is larger than the unity, the dust ring is self-sustained. Finally collisions between ring particles may decrease dust size and increase dust eccentricity; smaller particles (<22micron) are captured with Mars. The lifetime (actually mean collision time) of Phobos' ring particles is about ten years [15].

Sasaki estimated the erosion rate of Phobos' surface when the self-sustaining effect is operated [15]. When dust radius is larger than 40micron, the surface erosion rate is larger than 10^{-6} m/yr at $\eta = 2$. The Phobos' orbit is approaching Mars because of the tidal interaction with Mars. Residence time of Phobos in its eccentricity enhancement zone ($3.5R_M$ to the present $2.8R_M$: R_M being Martian equatorial radius) is in the order of 10^7yr [8]. This might have eroded Phobos' surface by 10m on average.

Satellite-Derived Dust on the Surface: Since the change of inclination is less than 0.01, inclination of the Phobos' dust ring i is at most 0.02 (inclination of Phobos being 1.08degree = 0.019). As seen in Fig. 1, the ring particle would collide only on the equatorial region on Mars. The total capture area S is approximately $2\pi R^2 \Delta R = 4\pi R^2 i = 2.9x10^6$ km^2. This is only 1800 times as large as the surface area of Phobos, $1.6x10^3$ km^2. If the Phobos' surface was eroded by 10m (1m) on average, the equatorial region of Mars is covered with Phobos-derived particles by 6mm (0.6mm) thickness. This is larger than the estimated infalling micrometeorites flux in 10^7yr (0.1mm thickness from $0.3x10^{-16}$ g/cm^{-2}s [1] originally [19]).

On the other hand, inclination of particles from Deimos is largely enhanced; they form an extended dust torus with inclination as large as 0.2 (Fig. 2). Deimos-derived particles fall onto Martian surface area 10 times as large as that of Phobos-derived particles. Moreover, erosion rate of Deimos is 30-100times smaller than that of Phobos [15]. Therefore, concentration of Deimos-derived particles on the equatorial region on Mars would be 300-1000 times lower than that of Phobos-derived particles.

Size of captured dust particles would be larger than that of suspended dust in the atmosphere (~micron); they would once accumulate on the surface. Although later dust transport may diffuse the surface distribution, abundance of Phobos-derived particles would be higher on the equatorial region of Mars. If future Martian missions return the surface samples of the equatorial region, they would contain Phobos-derived particles whose composition would be different from Mars and might be rich in carbonaceous materials.

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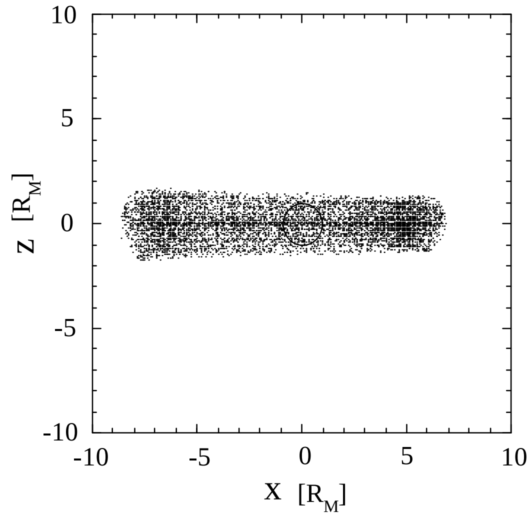

Figure 1 Distribution of dust particles of radius 40micron. Particles from Phobos on x-z plane. On the Martian equatorial plane (z=0), +x is the direction of the sun. Mars is expressed by the central circle.

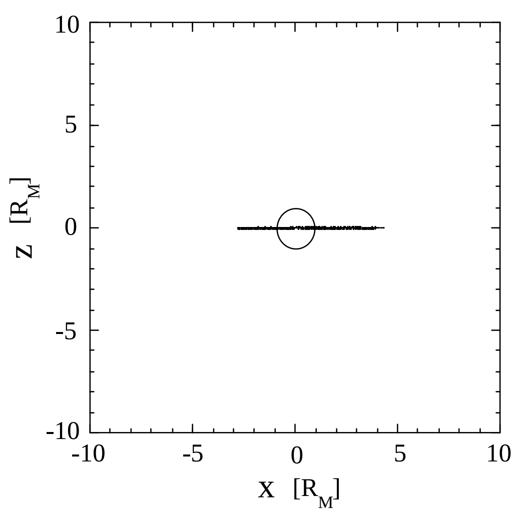

Figure 2 Distribution of dust particles of radius 40micron. Particles from Deimos on x-z plane. On the Martian equatorial plane (z=0), +x is the direction of the sun. Mars is expressed by the central circle.