ORIGIN OF THE MARTIAN SATELLITES PHOBOS AND DEIMOS.

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Introduction: The origin of the Martian satellites presents a puzzle of long standing. Conventional hypotheses either violate physical laws or have difficulty accounting for the observed orbits. Both satellites have near-circular and near-equatorial orbits. Phobos' orbit has been observed to shrink (since its discovery in 1877), indicating the influence of tidal perturbations. Extrapolating their orbits backward in time yields nearly identical circular orbits at the synchronous limit, developing into parabolic orbits suggesting **individual capture [1].** But there is no ready mechanism for energy dissipation to capture these small bodies; nor should capture yield equatorial orbits**.**

Contemporaneous formation with the planet Mars is contradicted by dynamics. The obliquity of Mars' axis, about 25 , indicates formation by stochastic impacts of large planetesimals, at least in the last stages of Mars accumulation. But the equatorial orbits of the satellites would require that the obliquity of Mars changed quasi-adiabatically, i.e., very slowly compared to the orbital periods of the moons. This suggests that Mars acquired the moons only after its formation was completed, but it leaves the mechanism uncertain**. [2]**

With capture and contemporaneous formation both unlikely, we propose a third possibility: **Capture of a large Mars-Moon** (now disappeared), during or shortly after the formation of the planet, with Phobos and Deimos as its surviving remnants. Arguments are given in favor of such a hypothesis and illustrative examples are shown.

Arguments for a Mars-Moon Capture Origin :

1. Capture of a large body is dynamically easier, since the greater tidal friction is likely to dissipate sufficient kinetic energy to turn an initially hyperbolic orbit into a bound elliptic orbit.
2. A large Mars-Moon ***(M-M)*** would change the angular momentum of Mars in the capture process. Analogous to the Earth-Moon case, our calculations show that M-M's initial orbit would be inclined and even retrograde, but its final orbit would be prograde, near-equatorial, and at the synchronous limit (of Mars rotation).
3. Capture of M-M from a retrograde orbit would reduce the angular momentum of Mars, dissipate its kinetic energy of rotation internally, and contribute heat energy required for melting. It could also explain its present low spin rate.
4. The close passage of the Mars-Moon within the Roche limit would have fractured it. Tidal friction would soon drive the largest pieces into Mars, with the smallest pieces remaining as Phobos and Deimos. Phobos is spiraling into Mars now and will disappear in a few million years; but Deimos, beyond the synchronous orbit limit, will survive against tidal friction.
5. The present orbit of Phobos makes it likely that more massive fragments existed in the past and have spiraled into Mars because of tidal perturbation -- lifetime being inversely proportional to mass. ["If the dinosaurs had had better telescopes, they would have observed them."]
6. The present orbit of Deimos, just beyond the synchronous limit, provides an important clue about its origin
7. There are no ready alternatives to explain the origin of the Martian moons.

References:

[1] S.F. Singer. *Geophys. J. Royal Astron. Soc*. 15, 205-226, 1968;
[2]…"Origin of the Moon by Capture" in *The Moon* (W. Hartmann et al., ed.) LPI, Houston, 1986, pp, 471-485.