The Origin of Phobos and Deimos

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Even though much research and study has been done, the origin of Mars' moons Phobos and Deimos has yet to be fully understood. One idea is that they were captured by Mars's gravity. However, there are some problems with this theory, since due to tidal effects, Phobos is moving closer to Mars every orbit. As such, Phobos would have had to been placed just inside of synchronous orbit at capture in order for it to be located at its current location.

In Craddock 2011, it is theorized that the origin of the martian moon's come involves a collision between Mars and a smaller planetesimal, of about 1800 km in size. This theory works to solve several of observed problems within the Mars-satellite system; for example, observations of Mars's spin rate suggest that Mars has more angular momentum then can be explained in an ordered accretion model (Craddock 2011), but can be explained using a stochastic accretion model.

Dones & Tremaine 1993 suggest that a collision with a massive object could provide increased spin to a planetary system. This could be the source of added angular momentum to the martian system. The small orbital eccentricity and inclination of the satellites' orbits is the hardest to explain in the capture scenario . In a collision theory, the circular orbits and small inclination are the natural result of accretion from a circumplanetary disk such as would occur from a collision. However, a satellite formed from an accretion disk would tend to have very little inclination whereas Phobos and Deimos have orbits with slight inclinations, more than can be easily described by this theory.

There is evidence of Mars's surface for such an collision in the giant surface impacts. There are some that are large enough that the energy involved in the collision is enough to have vaporized enough material into a disk to create Phobos and Deimos. Research has also been done that shows that the decay of smaller moonlets formed from the disk may be recorded in the location of oblique craters on the martian surface. If this is the case, than looking at these craters can give a rough estimate of the mass of all the moonlets, and therefore the impacter. This mass can then be compared to the impacter mass needed to increase the angular moment of the system.

As a research project, I will look into the mass of the progenitor through these two methods. This is can be done analytically looking at the increased angular momentum seen in the spin rate of Mars as well as the sizes and shapes of the larger impact sites on Mars's surface.

References

Craddock, Robert A. 2011. "Are Phobos and Deimos the result of a giant impact?" Icarus, Volume 211, Issue 2, February 2011, Pages 1150-1161

Dones & Tremaine. 1993. "Why Does the Earth Spin Forward?" Science, Volume 259, 15 Jan. 1993, Pages 350-354