

Abstract:

Among all planets in our Solar System no moons have been discovered around Mercury and Venus. Thus the question is why Venus and Mercury do not have a natural satellite. It is also not known whether Venus or Mercury ever had a moon in their early stage of their evolution.

Earth has its moon and Mars has two tiny natural satellites, Phobos and Deimos. In addition all the outer planets have a very extensive system of natural satellites. However, most of them are very small, much smaller than our Earth's moon. About half a dozen of them have comparable sizes to the Earth's moon: the four Galilean satellites Io, Europa, Ganymede and Callisto, Saturn's Titan, and Neptune's Triton. Saturn has an additional six mid-sized moons massive enough to have achieved hydrostatic equilibrium, and Uranus has five. It has been suggested that some satellites may potentially harbor life, however, this has not been confirmed or proofed so far.

The accepted explanation for the origin of the Moon is a giant impact. Given current theories of Solar System formation, it is unlikely that Venus or Mercury would have avoided similar collisions. Simulations suggest that most large collisions (see Fig. 1) create a disk from which a moon forms.

Here we discuss a few hypotheses why neither Venus nor Mercury have a moon.

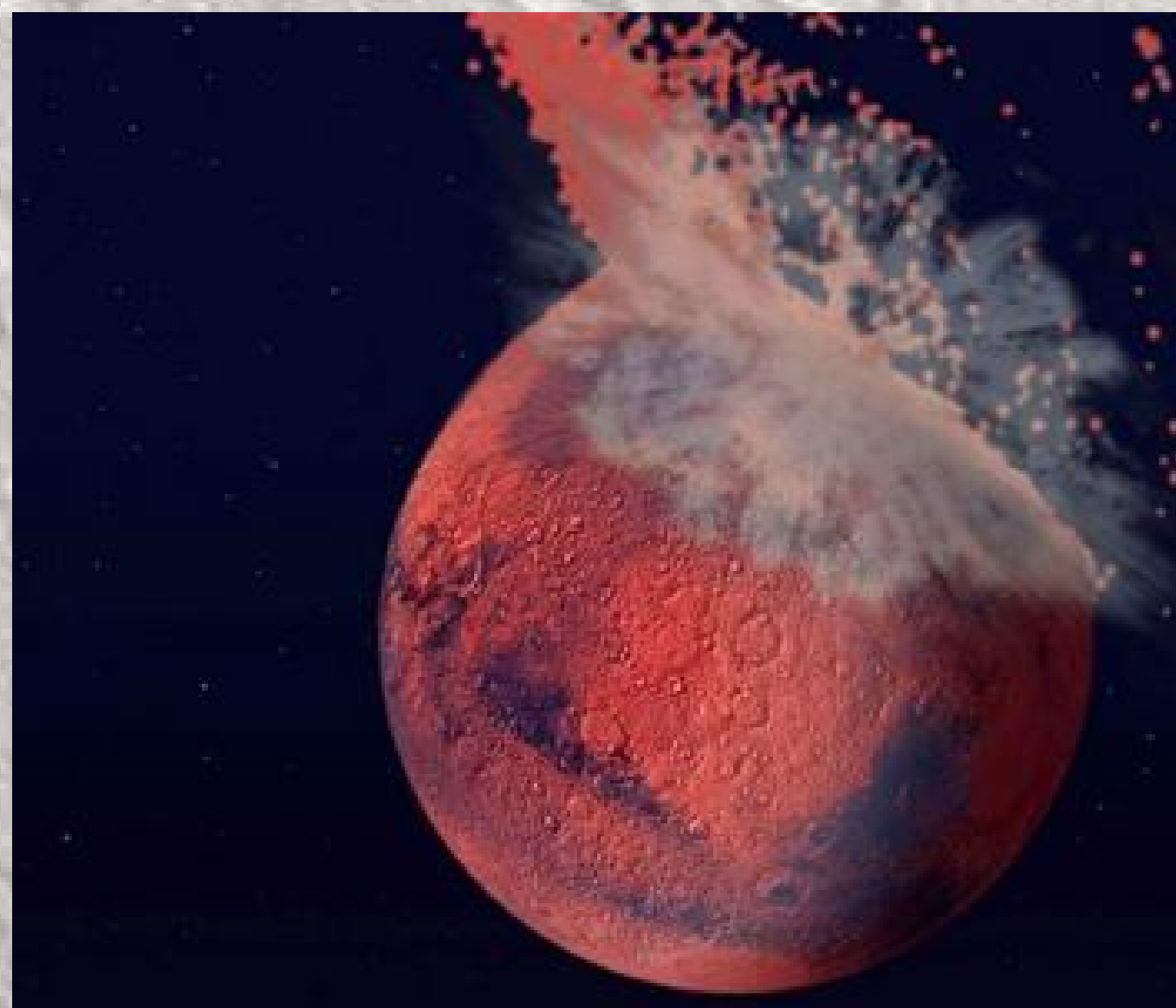


Figure1: Illustration of a giant collision at Mars

Hypotheses A:

Orbits of moons around Venus & Mercury are unstable

- Low rotation velocities of Mercury and Venus
- Synchronous orbit pushed very far
- Moons inside the synchronous orbit spiral inward and eventually collide with the planet
- More massive satellites are removed more quickly than less massive ones

Hypotheses C:

Mercury is a "lost" moon

- New volatile composition measurements made by MESSENGER indicate a different formation place of Mercury, much closer to Venus and Earth.
- As a provocative statement, Mercury could be a lost moon of Venus or Earth.

References

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On April 1st, 2012 the NASA MESSENGER team announced The discovery of a moon around Mercury. Although this was a joke we ask ourselves: Why Mercury does not have a moon?

MESSENGER NEWS (1. April 2012):this discovery image provides the first evidence that Mercury has a small natural satellite or moon. Visible as a small bright spot in an image taken yesterday by the Mercury Dual Imaging System (MDIS) Wide Angle Camera (WAC), the moon is approximately 70 meters (230 feet) in diameter and orbits Mercury at a mean distance of 14,300 km (8,890 miles). A proposal to name the moon "Caduceus," after the staff carried by the Roman god Mercury, has been submitted by the MESSENGER team to the International Astronomical Union, the body responsible for assigning names to celestial objects.

Figure 2: Moon around Mercury (indicated by the arrow. Close-up image inside box). Credit: NASA MESSENGER-team

Hypotheses B:

Alemi and Stevenson 's model (Venus)

- Venus was hit (as a major collision) twice in its history. First collision: formation of a moon. The satellite slowly spiraled away from the planet, due to tidal interactions, much the way our Moon is still slowly escaping away from Earth. Second collision: opposite direction, planet spin reversed.
- Venus's new direction of rotation -> absorption of the moon's orbital energy via tides -> the moon spiraled inward until it collided with Venus.

Conclusions B:

We asked ourselves the question: Why Mercury and Venus do not have a moon. There are not many articles in literature dealing with this topic. It looks like that the orbit and the rotation rates of these two planets play a key role to answer this question. It cannot rule out that both planets have had a moon in the past. However, especially in the case of Mercury the tidal friction from the sun seemed to slow down the rotation. A slow rotation results into planet-satellite tides, which cause the moon to spiral inward toward the planet. [3][4]. For Venus the retrograde motion seems to cause the satellite to spiral towards the planet. Other authors argue that the Earth-Moon system stabilize the orbits of Venus and Mercury in a special resonance state, which will not allow stable orbits of a moon over a very long time [5][1].