

Astronomy[®]

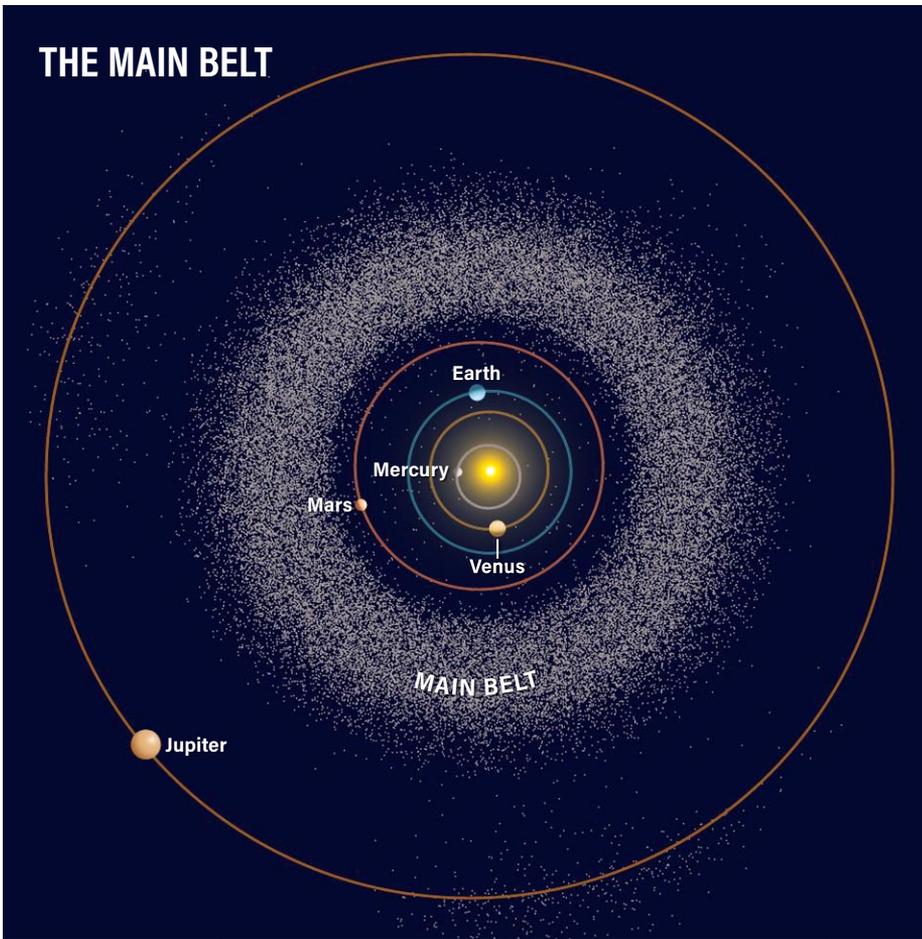
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SPECIAL ISSUE

EARTH AS A PLANET

WHERE WE ARE, WHERE WE'VE BEEN,
AND WHERE WE GO FROM HERE

**BONUS
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The majority of known asteroids orbit in the main belt between Mars and Jupiter. It is unlikely that the many bodies here were ever part of a single planet. This illustration shows the positions of the planets and all numbered asteroids on Jan. 1, 2018.

ASTRONOMY: ROEN KELLY, AFTER P. CHODAS (NASA/JPL)

A lost planet?

Q | IS THERE EVIDENCE OF A PLANET EVER EXISTING BETWEEN MARS AND JUPITER?

Mark
Smithtown, New York

A | This splendid question gives us an opportunity to distinguish between what we know and what we believe might be true.

First, we know that myriad small bodies orbit the Sun between Mars and Jupiter. These objects are the asteroids that comprise the main belt. Astronomers estimate that 1.1 million to 1.9 million asteroids with diameters equal to or exceeding 0.6 mile (1 kilometer) are located within this region, with millions more smaller asteroids likely lurking as well. That's quite a substantial number of rocks. It would seem as though those asteroids could

form quite a planet if put together. But, surprisingly, if all the main-belt bodies were to coalesce, the resultant world's mass would only be 4 percent that of the Moon. (To put that value into perspective, the Moon's mass is only 1.2 percent that of Earth.) And half of that mass is concentrated in the four largest bodies: Ceres, Vesta, Pallas, and Hygiea.

The notion that these fragments could have come from a planet that was somehow reduced to fragments arose out of the 1801 discovery of Ceres by Giuseppe Piazzi and the 1802 discovery of Pallas by Heinrich Olbers. Olbers became convinced that these two bodies were pieces of a larger world that had once existed, and the subsequent discoveries of Juno (1804) and Vesta (1807) lent credence to this belief. The hypothetical doomed planet was soon thereafter given the name Phaëthon (or Phaeton), after the ill-fated son of the Greek Sun god Helios, who tried to drive his father's chariot for one day and perished as a result. This idea evolved into what was known in the 20th century as the disruption theory, which stated that a planet between Mars and Jupiter had been destroyed by some unknown means, perhaps tidal interactions with Jupiter or a collision with another body.

Could the main belt have formed from the remains of a destroyed planet? How could we know one way or the other? One important clue practically fell into our laps. Iron meteorites on Earth that are known to have come from the main belt have been determined not to have all originated from the same body. The patterns within these meteorites are quite different from one another; fragments of a single world would show more similarities. The analysis of these meteorites, combined with the comparative dearth of material within the main belt, leads us to believe that no planet ever existed between the orbits of Mars and Jupiter after all. The asteroids are likely just remnants from the early days of solar system formation.

Moreover, we shouldn't expect any planet to form within the main belt in the future, since Jupiter's considerable gravitational influence keeps the asteroids in a perpetual spin cycle, preventing them from gathering together to make a new world.

We can't assert that no planet ever existed between Mars and Jupiter. We can, however, say that it is highly unlikely one ever did.

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