Missing asteroids explained?

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Courtesy University of Arizona
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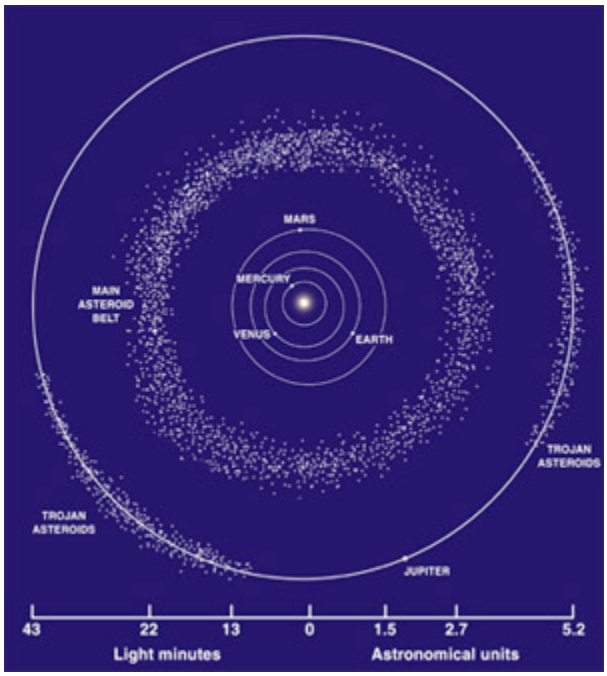
Scientists have reported a case of missing asteroids—and a possible explanation.

The main asteroid belt is a zone containing millions of rocky objects orbiting the Sun between the orbits of Mars and Jupiter. But there ought to be more asteroids there than are seen, say University of Arizona graduate student David A. Minton and planetary sciences professor Renu Malhotra.



Asteroids are material left over from the formation of the solar system. One theory suggests that they are the remains of a planet that was destroyed in a massive collision long ago. More likely, asteroids are material that never coalesced into a planet. In fact, if the estimated total mass of all asteroids was gathered into a single object, the object would be less than 1,500 kilometers (932 miles) across, less than half the diameter of our Moon. The asteroid belt lies in the region between Mars and Jupiter. The Trojan asteroids lie in Jupiter's orbit, in two distinct regions in front of and behind the planet. (Image courtesy NASA)

They propose the missing asteroids are a clue supporting a theory that the early solar system underwent a violent episode of giant planet migration. Such a journey might have triggered a great asteroidal bombardment of the inner planets, such as ours.

The research is detailed in the Feb. 26 issue of the journal *Nature*.

Astronomers discovered a series of gaps in the asteroid belt, now called the Kirkwood gaps, in the 1860s when few asteroids were known.

The gaps occur at distinct regions of the belt where Jupiter's and Saturn's gravity disturb and eject asteroids. The two giant planets' present-day orbits explain why these unstable regions are asteroid-free, astronomers say.

Minton said he and Malhotra investigated "how much of the structure of the asteroid belt could be explained simply by the gravitational effects of the giant planets, as are the Kirkwood gaps."

The pair looked at the distribution of asteroids wider than 50 kilometers (about 30 miles). All asteroids this large are thought to have been found, and to have remained intact since the belt formed more than four billion years ago near the very beginning of solar system history.

"We ran massive sets of simulations with computer planets where we filled up the asteroid belt region with a uniform distribution of computer asteroids," Minton said. The scientists then had the computers simulate the billions of years of solar system history. Their simulations ultimately ended with far more asteroids than are actually seen in the belt.

Comparing the simulated and the real asteroid belts, they pair discovered an odd pattern. The simulated belt matched the real one quite well on the sunward sides of the Kirkwood gaps, but had more objects on the Jupiter-facing sides.

"Then we simulated the migration of the giant planets," Minton said. "The perturbing effects of the migrating planets sculpted our simulated asteroid belt. After the migration was over, our simulated asteroid belt looked much more like the observed" one. It seems that as the two planets migrated, their gravitational effects swept through the asteroid belt, tossing out asteroids wholesale, Malhotra said.

"The patterns of depletion are like the footprints of wandering giant planets preserved in the asteroid belt," Minton said. The findings, he added, corroborate other evidence indicating that the giant planets—Jupiter, Saturn, Uranus and Neptune—formed in a more tightly compacted configuration. Jupiter then would have moved slightly closer to the sun, while the other giant planets moved farther apart from each other and from the sun.

Minton and Malhotra say their result has implications for how far and how fast the planets migrated early in solar system history, and the possibility that planet migration perturbed asteroids that may have contributed to a heavy bombardment of the inner solar system.

"Our result doesn't directly answer the question of whether the timing of this can be tied to inner solar system heavy bombardment—that's open for debate," Minton said. "But what it does say is that there was an event that destabilized asteroids over a relatively short period of time…. all the asteroids being kicked out of the asteroid belt had to go somewhere."

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