Published on *UANews* (http://uanews.org)

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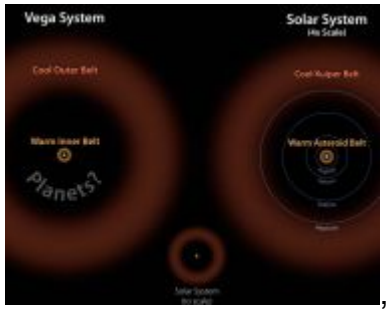
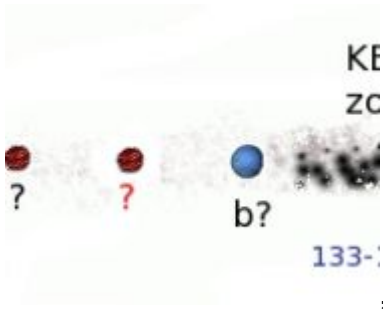
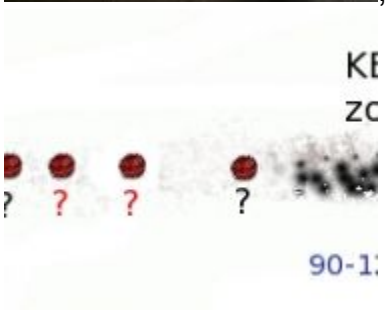
A UA-led team of astronomers has discovered inner asteroid belts and outer comet-filled belts similar to the arrangement found in our solar system around nearby stars Vega and Fomalhaut. A wide gap between the inner and outer belts strongly hints at the existence of yet undiscovered planets circling the bright stars.





Vega, the second brightest star in northern night skies, has an asteroid belt much like our sun, discovered by a University of Arizona-lead team of astronomers. A wide gap between the dust belts in nearby bright stars is a strong hint of yet-undiscovered planets orbiting the stars.

The findings from the Infrared Space Telescopes are the first to show an asteroid-like belt ringing Vega. The discovery of an asteroid belt around Vega makes it more similar to its twin, a star called Fomalhaut, than previously known. Both stars now are known to have inner, warm asteroid belts and outer, comet-filled belts, similar in architecture to the asteroid and Kuiper belts in our own solar system.

“Finding an asteroid belt similar to the one in our solar system and other nearby bright stars is exciting,” said **Kate Su**, an astronomer at **Steward Observatory** at the UA. Su is

lead author of a paper on the findings accepted for publication in the Astrophysical Journal.

The **Spitzer** and **Herschel** telescopes detected infrared light emitted by warm and cold dust in discrete regions around Vega and Fomalhaut, revealing the existence of the debris disks. Both belts in our solar system contain "planetesimals" – leftover “crumbs” that didn’t make it into planets.

“The wide gap between the two debris belts strongly suggests that multiple planets orbit these stars even though we can’t see them,” Su explained. “We know this because in systems without planets, the debris material is evenly distributed.”

Su explained planets create gaps in debris disks by a process called “sculpting.”

“Planets scatter the objects under their gravitational influence. Over time, you won’t see any dust or planetesimals in the region where they reside.”

The structure of the debris around Vega and Fomalhaut is divided into an inner "warm" belt and an outer "cold" belt with a large gap separating them. The temperature of the “warm” belt was measured to be minus 190 degrees Fahrenheit, while the outer belt is minus 370 degrees, far colder than any place on Earth.

In our solar system, the inner asteroid belt between Mars and Jupiter is maintained by the gravity of the terrestrial planets and the giant planets. The giant planets exclusively sculpt the outer Kuiper belt. Unlike Kuiper belt objects, which resemble “dirty snowballs” because they contain large amounts of water ice, objects in the asteroid belt don’t stay cold enough to retain much ice, which sublimates into space, leaving behind rocky bodies. Comets, on the other hand, originate from the Kuiper belt and the outer part of the solar system.

“We can’t see the asteroids, but the product of their collisions with each other,” Su said. "Vega and Fomalhaut really live up to their nicknames as 'debris disk twins' because both have warm, asteroid-like and cold, Kuiper belt-like disks of material.”

Comets and the collisions of rocky planetesimal chunks replenish the dust in these bands. The asteroid belts in these systems cannot be seen in visible light because they are too close to their host stars and are outshined by the glare of their stars.

Vega and Fomalhaut are like twins in other ways. Both possess about twice the mass of our sun and burn a hotter, bluer color in visible light. Both stars are relatively nearby at about 25 light-years away and are similar in age, about a half-billion years. Our sun is 4.5 billion years old.

Fomalhaut has a single known candidate planet orbiting it, Fomalhaut b, which stands as one of the dozen or so exoplanets that have been directly imaged by ground- or space-based instruments. No planets have been detected around Vega, but the new observations strongly suggest their presence.

Both the inner and outer belts contain far more material than our own asteroid and Kuiper belts. The reason is twofold: The star systems are far younger than our own, which has had hundreds of millions of more years to clean house, so to speak, and the systems

formed from an initially more massive cloud of gas and dust than our solar system.

The gap between the inner and outer debris belts for Vega and Fomalhaut also proportionally corresponds to the distance between our sun's asteroid and Kuiper belts. This distance works out to a ratio of about 1:10, with the outer belt 10 times farther away from its host star than the inner belt. In our solar system, the asteroid belt lies roughly two to three times farther from the sun than the Earth, and the Kuiper belt starts at around 30 times the sun-Earth distance. Vega's and Fomalhaut's asteroid belts begin about four times more distant than our own asteroid belt, again in proportion to their system's higher mass and luminosity.

As for the large gap between the two belts, a single, supersized planet dozens of times the mass of Jupiter could gravitationally carve out such an area by clearing and accreting stray dust. But previous planet-hunting surveys would have spotted any object of that magnitude. Instead, several Jupiter-sized or smaller planets that have not been detected yet better fit the bill for creating a dust-free zone between the debris disks. A good comparison star system is HR 8799, which has four known planets that sweep up the space between two similar disks of debris.

"Overall, the large gap between the warm and the cold belts is a signpost that points to multiple planets likely orbiting around Vega and Fomalhaut," said Su. "Our finding echoes other recent research which indicates low-mass planets are more numerous than massive ones and that multiple exoplanet systems are also rather common."

If unseen planets do in fact orbit Vega and Fomalhaut, these bodies will not likely stay hidden for long. "Upcoming new facilities should be able to find the planets," said paper co-author **Karl Stapelfeldt**, chief of the Exoplanets and Stellar Astrophysics Laboratory at **Goddard Space Flight Center**.

Herschel is a **European Space Agency** cornerstone mission, with science instruments provided by consortia of European institutes and with important participation by **NASA**. NASA's **Jet Propulsion Laboratory** contributed mission-enabling technology for two of Herschel's three science instruments. JPL also manages the Spitzer Space Telescope mission for NASA's Science Mission Directorate, Washington. Science operations are conducted at the **Spitzer Science Center** at Caltech, also in Pasadena. Caltech manages JPL for NASA.
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