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Astronomers gear up to discover Earth-like planets

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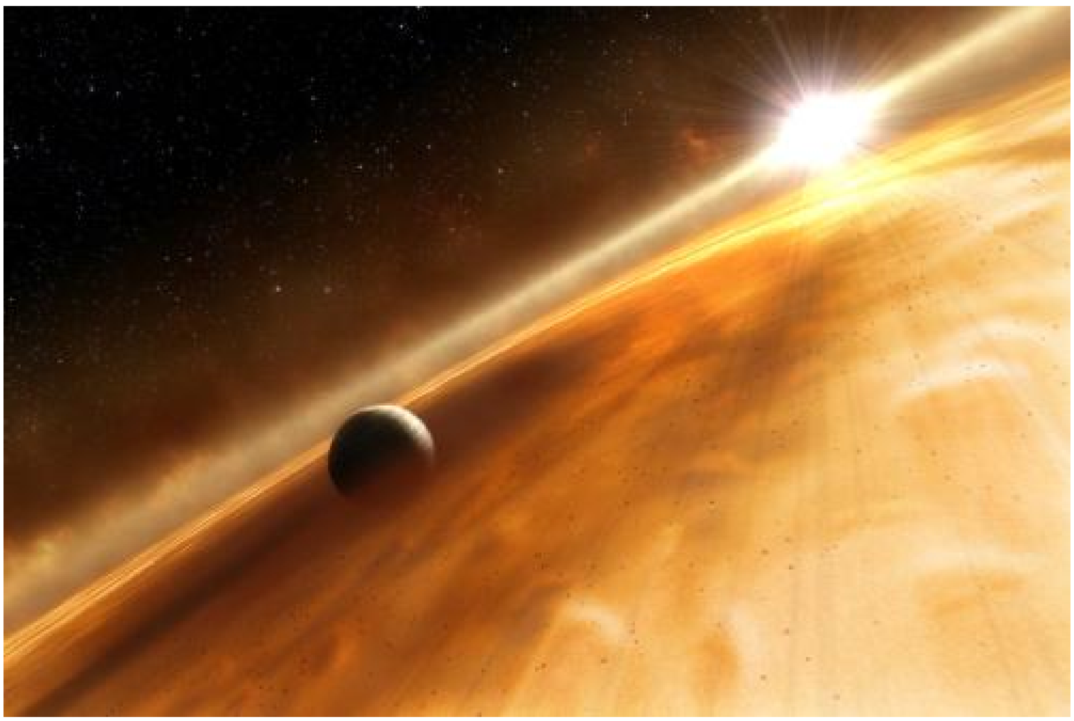

Many stars are enshrouded in a dust cloud that may hide undiscovered planets with conditions suitable to life. The star Fomalhaut, depicted in this artist's impression, was recently found to have a faint dust cloud in a region resembling the Main Asteroid Belt in our solar system that might harbor yet undetected planets. Credit: ESA, NASA and L. Calcada/ESO

If one looks only for the shiniest pennies in the fountain, chances are one misses most of the coins because they shimmer less brightly. This, in a nutshell, is the conundrum astronomers face when searching for Earth-like planets outside our solar system.

Astronomers at the University of Arizona are part of an international team of exoplanets hunters developing new technology that would dramatically improve the odds of discovering planets with conditions suitable for life – such as having liquid water on the surface.

The team presented its results at a scientific conference sponsored by the International Astronomical Union in Victoria, British Columbia.

Terrestrial planets orbiting nearby stars often are concealed by vast clouds of dust enveloping the star and its system of planets. Our solar system, too, has a dust cloud, which consists mostly of debris left behind by clashing asteroids and exhaust spewing out of comets when they pass by the sun.

"Current technology allows us to detect only the brightest clouds, those that are a few thousand times brighter than the one in our solar system," said Denis Defrère, a postdoctoral fellow in the UA's department of astronomy and instrument scientist of the Large Binocular Telescope Interferometer, or LBTI.

He explained that while the brighter clouds are easier to see, their intense glare makes detecting putative Earth-like planets difficult, if not impossible. "We want to be able to detect fainter dust clouds, which would dramatically increase our chances of finding more of these planets."

"If you see a dust cloud around a star, that's an indication of rocky debris , and it increases the likelihood of there being something Earth-like around that star," said Phil Hinz, an associate professor of astronomy at the UA's Steward Observatory.

"From previous observations, we know that these planets are fairly common," he added. "We can expect that if a space telescope dedicated to that mission were to look around a certain area of sky, we'd expect to find quite a few."

Hinz and Defrère are working on an instrument that will allow astronomers to detect fainter clouds that are only about 10 times – instead of several thousand times – brighter than the one in our solar system.

"It's like being here in Victoria and trying to image a firefly circling a lighthouse in San Francisco that is shrouded in fog," Defrère said about the technological challenge.

"That level of sensitivity is the minimum we need for future space telescope missions that are to characterize Earth-like planets that can sustain liquid water on the surface," he explained. "Our goal is to eliminate the dust clouds that are too bright from the catalog of candidates because they are not promising targets to detect planets suitable for life."

"With a bright dust cloud, which is 1,000 times brighter than the one in our solar system, its light becomes comparable to that of its star, which makes it easier to detect," explained Hinz.

Fainter clouds, on the other hand, can be about 10,000 times less bright than their star, so it becomes difficult or impossible for observers to make out their faint glow in the star's overpowering glare.

Funded by NASA, the team is in the middle of carrying out tests to demonstrate the feasibility of these observations using both apertures of the Large Binocular Telescope, or LBT, in Arizona. The project aims at determining how difficult it would be to achieve the desired results before committing to a billion-dollar space telescope mission.

According to Hinz, NASA's goal is to be able take a direct picture of Earth-like, rocky planets and record their spectrum of light to analyze their composition and characteristics such as temperature, presence of water and other parameters.

"To do that, one would need a space telescope specifically designed for this type of imaging," he said. "Our goal is to do a feasibility study of whether it would be possible to distinguish the light emission of the planet from the background emission of the dust cloud through direct observation."

The researchers take advantage of a technique known as nulling interferometry and the unique configuration of the LBT, which resembles a giant pair of binoculars.

"We combine the light from two apertures, cancel out the light from the central star, and with that it becomes easier to see the light from the dust cloud," Hinz explained. "To achieve this, we have to cause the two light paths to interfere with each other, which requires lining them up with very high precision. We'll always have some starlight left because of imperfections in the system, but our goal is to cancel it out to a level of 10,000 to get down to where we can at least detect the faint glow of the dust cloud."

The work presented at the conference used the same technique with the two large telescopes of the Keck Observatory in Hawaii in order to detect the dust cloud around the star Fomalhaut located 25 light years from our sun.

"Based on our observations at the European Very Large Telescope Interferometer, we knew that Fomalhaut was surrounded by a bright dust cloud located very close to the star," said Jérémy Lebreton, principal investigator of the study, who is at the Institut de Planétologie et d'Astrophysique in Grenoble, France.

"Using the Keck Interferometer, we found out that Fomalhaut has a less bright, more diffuse cloud orbiting close to the habitable zone that resembles the Main Asteroid Belt in our solar system. This belt is likely in dynamical interaction with yet undetected planets."

The study presented here is one in a series of three publications and was conducted in collaboration with the University of Amsterdam; the University of Liège in Belgium; NASA's Jet Propulsion Laboratory at Caltech, Pasadena, Calif.; the University of Paris; and the University of Arizona in Tucson, Ariz.

Approximately 250 scientists from around the world convened at the scientific conference, Exploring the Formation and Evolution of Planetary Systems, held June 3-7 in Victoria to discuss the latest observations and theories about exoplanetary systems.

More information: This research paper, An interferometric study of the Fomalhaut inner debris disk. III. Detailed models of the exozodiacal disk and its origin, by Lebreton J. et al. is online at arxiv.org/abs/1306.0956

Provided by University of Arizona

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