

Astronomers discover planet that never was

April 20 2020, by Daniel Stolte



Clash of Titans: This artist's illustration depicts the collision of two 125-mile-wide icy, dusty bodies orbiting the bright star Fomalhaut, located 25 light-years away. Credit: ESA, NASA and M. Kornmesser

What astronomers thought was a planet beyond our solar system has now seemingly vanished from sight, suggesting that what was heralded as one of the first exoplanets to ever be discovered with direct imaging likely never existed.

Two University of Arizona astronomers conclude that NASA's Hubble Space Telescope was instead looking at an expanding cloud of very fine dust particles from two icy bodies that smashed into each other. Hubble came along too late to witness the suspected collision but may have captured its aftermath. The missing-in-action planet was last seen orbiting the star Fomalhaut, 25 [light years](#) away.

"These collisions are exceedingly rare and so this is a big deal that we actually get to see evidence of one," said Andras Gaspar, an assistant astronomer at the University of Arizona's Steward Observatory and lead author of a research paper announcing the discovery. "We believe that we were at the right place at the right time to have witnessed such an unlikely event with NASA's Hubble Space Telescope."

"The Fomalhaut star system is the ultimate test lab for all of our ideas about how exoplanets and [star systems](#) evolve," added George Rieke, a Regents Professor of Astronomy at Steward Observatory. "We do have evidence of such collisions in other systems, but none of this magnitude has been observed in our solar system. This is a blueprint of how [planets](#) destroy each other."

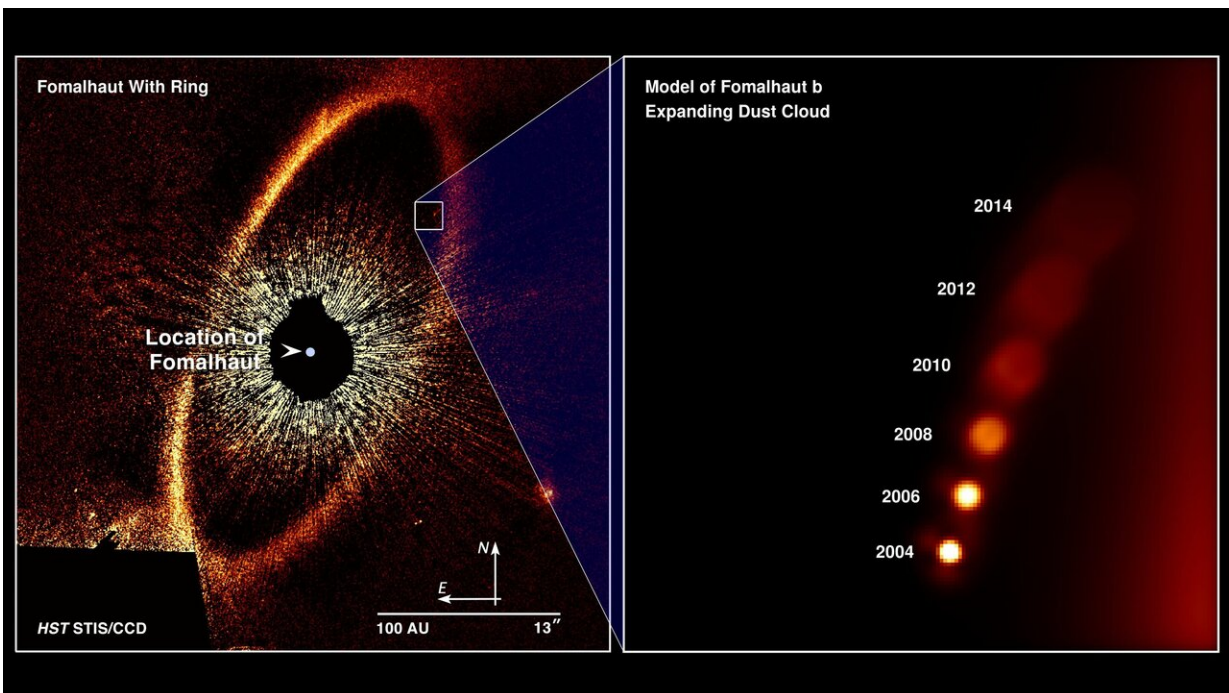
The suspected exoplanet, named Fomalhaut b, was first announced in 2008, based on data from 2004 and 2006. It was clearly visible in several years of Hubble observations, which revealed it was a moving dot. Until then, evidence for exoplanets had mostly been inferred through indirect detection methods, such as subtle back-and-forth stellar wobbles and shadows from planets passing in front of their stars.

Unlike other directly imaged exoplanets, however, puzzles arose with Fomalhaut b. The object was bright in visible light—highly unusual for an exoplanet, which is simply too small to reflect enough light from its host star to be seen from Earth. At the same time, it did not have any detectable infrared heat signature—again, highly unusual, as a planet

should be warm enough to shine in the infrared, especially a young one like Fomalhaut b. Astronomers conjectured that the added brightness came from a huge shell or ring of dust encircling the planet that may have been collision-related.

"Our study, which analyzed all available archival Hubble data on Fomalhaut, revealed several characteristics that together paint a picture that the planet-sized object may never have existed in the first place," Gaspar said.

The team emphasizes that the final nail in the coffin came when their data analysis of Hubble images taken in 2014 showed the object had vanished, to their disbelief. Adding to the mystery, earlier images showed the object to continuously fade over time, they say.



This diagram simulates what astronomers, studying Hubble Space Telescope observations, taken over several years, consider evidence for the first-ever

detection of the aftermath of a titanic planetary collision in another star system. The color-tinted Hubble image on the left is of a vast ring of icy debris encircling the star Fomalhaut, located 25 light-years away. The star is so brilliant that a black occulting disk is used to block out its glare so that the dust ring can be photographed. In 2008, astronomers saw what they thought was the first direct image of a planet orbiting far from the star. However, by 2014, the planet candidate faded below Hubble's detection. The best interpretation is that the object wasn't ever a fully formed planet at all, but an expanding cloud of dust from a collision between two minor bodies, each about 125 miles across. The diagram at the right is based on simulation of the expanding and fading cloud. The cloud, made of very fine dust particles, is currently estimated to be over 200 million miles across. Smashups like this are estimated to happen around Fomalhaut once every 200,000 years. Therefore, Hubble was looking at the right place at the right time to capture this transient event. Credit: NASA, ESA, A. Gáspár and G. Rieke/University of Arizona

"Clearly, Fomalhaut b was doing things a bona fide planet should not be doing," Gaspar said.

The interpretation is that Fomalhaut b is slowly expanding from the smashup that blasted a dissipating dust cloud into space. Taking into account all available data, Gaspar and Rieke think the collision occurred not too long prior to the first observations taken in 2004. By now, the debris cloud—consisting of dust particles around 1 micron in size, or about 1/50th the diameter of a human hair—is below Hubble's detection limit. The dust cloud is estimated to have expanded by now to a size larger than the orbit of Earth around the sun.

Equally confounding is that the team reports that the object is more likely on an escape path, rather than on an elliptical orbit, as expected for planets. This is based on the researchers adding later observations to the trajectory plots from earlier data.

"A recently created massive dust cloud, experiencing considerable radiative forces from the central star Fomalhaut, would be placed on such a trajectory," Gaspar said. "Our model is naturally able to explain all independent observable parameters of the system: its expansion rate, its fading and its trajectory."

Because Fomalhaut b is presently inside a vast ring of icy debris encircling the star Fomalhaut, colliding bodies would likely be a mixture of ice and dust, like the comets that exist in the Kuiper belt on the outer fringe of our [solar system](#). Gaspar and Rieke estimate that each of these comet-like bodies measured about 125 miles across, roughly half the size of the asteroid Vesta.

The authors say their model explains all the observed characteristics of Fomalhaut b. Sophisticated modeling of how dust moves over time, done on a cluster of computers at UArizona, shows that such a model is able to fit quantitatively all the observations. According to the author's calculations, the Fomalhaut system, located about 25 light-years from Earth, may experience one of these events only every 200,000 years.

Gaspar and Rieke—along with other team members—will also be observing the Fomalhaut system with NASA's upcoming James Webb Space Telescope in its first year of science operations. The team will be directly imaging the inner warm regions of the system, and for the first time in a star system other than our own, they will obtain detailed information about the architecture of Fomalhaut's elusive asteroid belt. The team will also search for bona fide planets orbiting Fomalhaut that might still await discovery.

The paper, "New HST data and modeling reveal a massive planetesimal collision around Fomalhaut," is published in the *Proceedings of the National Academy of Sciences (PNAS)*.

More information: András Gáspár et al., "New HST data and modeling reveal a massive planetesimal collision around Fomalhaut," *PNAS* (2020). www.pnas.org/cgi/doi/10.1073/pnas.1912506117

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