Dust Disks Hint at Baby Solar System

Radio and infrared images unveiled this week suggest that three nearby stars have recently spawned planets and may still be in the throes of forming complete planetary systems. These portraits, showing dust surrounding youthful stars from 10 million to about 350 million years old, may offer snapshots of what the Milky Way looked like shortly after the birth of the sun 4.5 billion years ago.

Planets are thought to arise from a disk of gas, dust, and ice swirling around young stars. As material within the disk collides and sticks together, small bodies build up into bigger ones. Tiny grains of dust in the inner part of the disk may evolve into rocky planets like Earth, while agglomerations of gas and dust may create more massive bodies like Jupiter and Saturn. It is primarily these heavyweights that clear out the dust and leave a hole in the inner part of the disk, which begins to resemble a doughnut.

Astronomers have glimpsed numerous newborn stars—too young to have begun making planets—swaddled in thick disks of dust. After more than a decade of searching, however, researchers had found only one example of a young star whose thinning, doughnut-shaped disk indicated it was well on its way to making planets. The disk around that star, Beta Pictoris, was first glimpsed in 1984 (SN: 2/3/96, p. 77).

Astronomers now report that they have detected thinning or doughnut-shaped disks around three additional stars.

At a NASA press briefing, two teams of astronomers presented infrared images of a disk of glowing dust encircling the youthful star HR 4796A, which lies about 220 light-years from Earth. The inner part of the disk radiates considerably less heat than the outer part, indicating that it contains significantly less dust.

One explanation is that one or more unseen planets have swept the region clear of debris, the researchers suggest. Although the star is only 10 million years old, theorists believe that Jupiter and Saturn had already formed by the time our sun was that age.

"This may be what our solar system looked like at the end of its main planetary formation phase," says Michael W. Werner of NASA's Jet Propulsion Laboratory in Pasadena, Calif.

He and his colleagues made their observations with a large, mid-infrared camera on Keck II, one of the twin 10-meter telescopes atop Hawaii's Mauna Kea. A separate team, which includes Ray Jayawardhana and Lee W. Hartmann of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass., used a 4-meter telescope at the Cerro Tololo Inter-American Observatory in La Serena, Chile.

Like the disk surrounding Beta Pictoris, which is 30 million years old, the doughnut encircling the more youthful HR 4796A is seen edge-on. Its inner edge is roughly the same distance from HR 4796A as Pluto's average distance from the sun, and its outer edge extends at least three times that distance. As a tool for understanding the formation of the solar system, says Hartmann, "this pushes us a lot closer to the time when we think the planets first formed."

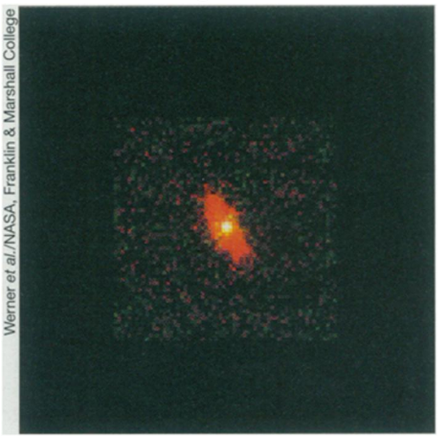
Two other stars, still quite youthful but more than 10 times as old as HR 4796A, also sport dusty disks, a third team of astronomers announced this week. Using the James Clerk Maxwell submillimeter radio telescope on Mauna Kea, researchers have found that two of the brightest stars in the sky, Fomalhaut and Vega, possess disks that may have begun to spawn planets. Wayne S. Holland of the Joint Astronomy Center in Hilo, Hawaii, Ben M. Zuckerman of the University of California, Los Angeles, and their colleagues report their findings in the April 23 NATURE.

Fomalhaut, about 200 million years old and 26 light-years from Earth, appears to be surrounded by a disk roughly centered on a cavity that may have been cleared by planets. The brightest emissions come from the parts of the disk located as far from Fomalhaut as a reservoir of comets beyond Pluto is from our sun.

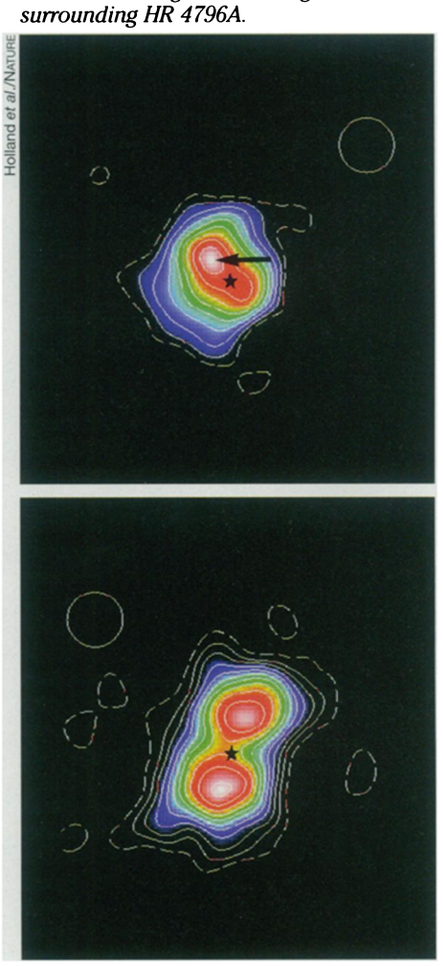
A radio image of Vega, estimated to be 350 million years old, has proved a puzzle, notes Zuckerman. The brightest emission comes from a single blob twice as far from Vega as Pluto's average distance from the sun. One possibility is that the blob represents dust orbiting a massive planet at that location. Alternatively, the blob might represent emissions from a distant galaxy located in the same region of the sky.

To their surprise, the researchers also found a blob adjacent to Beta Pictoris. That blob may be related to a much fainter one on the opposite side of the disk. The two blobs could represent material blown out in opposite directions from the center of the disk.

Taken together, the observations suggest that HR 4796A is twice as dusty as Beta Pictoris, which in turn has 100 to 1,000 times more dust than Vega or Fomalhaut. "This is a beautiful illustration of dustiness decreasing in time, and all these stages may have counterparts in the history of our solar system," says Pawel Artymowicz of Stockholm Observatory. —*R. Cowen*



False-color image of an elongated disk surrounding HR 4796A.



Radio images of dust disks surrounding Vega (top) and Fomalhaut (bottom). The position of the central star is denoted by the star symbol; white and red indicate the highest intensities. An arrow points to the mystery blob at Vega. White regions on either side of Fomalhaut represent expected emissions from the thickest parts of the disk, viewed edge-on.