Radio telescope images reveal planet-forming disk orbiting twin suns

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This artist's conception of the V4046 Sagittarii system highlights the disk-shaped molecular gas cloud imaged by the Submillimeter Array. The gaseous disk, which orbits the twin suns, shows that planets could form around double stars as easily as around a single star like our Sun. Credit: David A. Aguilar (CfA)

Astronomers are announcing today that a sequence of images collected with the Smithsonian's Submillimeter Array (SMA) clearly reveals the presence of a rotating molecular disk orbiting the young binary star system V4046 Sagittarii. The SMA images provide an unusually vivid snapshot of the process of formation of giant planets, comets, and Pluto-like bodies. The results also confirm that such objects may just as easily form around double stars as around single stars like our Sun.

These findings are being presented by UCLA graduate student David Rodriguez in a press conference at the American Astronomical Society meeting in Pasadena, Calif.

"It's a case of seeing is believing," says Joel Kastner of the Rochester (NY) Institute of Technology, the lead scientist on the study. "We had the first evidence for this rotating disk in radio telescope observations of V4046 Sagittarii that we made last summer. But at that point, all we had were molecular spectra, and there are different ways to interpret the spectra. Once we saw the image data from the SMA, there was no doubt that we have a rotating disk here."

Co-author David Wilner of the Harvard-Smithsonian Center for Astrophysics (CfA) adds, "This is strong evidence that planets can form around binary stars, which expands the number of places we can look for extrasolar planets. Somewhere in our galaxy, an alien world may enjoy double sunrises and double sunsets."

Wilner is one of the world's experts on radiointerferometry, the technique used in this study to form images with the SMA's multiple radio antennas. The other contributor to the SMA study of V4046 Sagittarii led by RIT's Kastner and UCLA's Rodriguez is Ben Zuckerman of UCLA.

According to Rodriguez, the images clearly demonstrate that the molecular disk orbiting the V4046 Sagittarii binary system extends from within the approximate radius of Neptune's orbit out to about 10 times that orbit. This region corresponds to the zone where the solar system's giant planets, as well as its Pluto-like Kuiper Belt objects, may have formed.

"We believe that V4046 Sagittarii provides one of the clearest examples yet discovered of a Keplerian, planet-forming disk orbiting a young star

system," Wilner says. "This particular system is made that much more remarkable by the fact that it consists of a pair of solar-mass stars that are approximately 12 million years old and are separated by a mere 5 solar diameters."

"This could be the oldest known orbiting protoplanetary molecular disk. It shows that, at least for some stars, formation of Jovian-mass planets may continue well after a few million years, which astronomers have deduced is characteristic of the formation time for most such planets," Zuckerman says.

Findings of this study build on previous work published in the December 2008 issue of Astronomy and Astrophysics in which Kastner and his team first suggested that the case of V4046 Sagittarii illustrates well how planets may form easily around certain types of binary stars.

"We thought the molecular gas around these two stars almost literally represented 'smoking gun' evidence of recent or possibly ongoing 'giant' Jupiter-like planet formation around the binary star system," Kastner says. "The SMA images showing an orbiting disk certainly support that idea."

The evidence for a molecular disk orbiting these twin young suns in the constellation Sagittarius suggested to the scientists that many such binary systems should also host as-yet-undetected planets.

"The most successful technique used so far for the discovery of extrasolar planets - that of measurement of precision radial velocities - is exceedingly difficult for close binary stars such as V4046 Sagittarii. So these radio observations are probing a new region of discovery space for extrasolar planets," says Rodriguez.

"At a distance of only 240 light-years from the solar system, the V4046

Sagittarii binary is at least two times closer to Earth than almost all known planet-forming star systems, which gives us a good shot at imaging any planets that have already formed and are now orbiting the stars," he continues.

Kastner and collaborators had previously used the 30-meter radiotelescope operated by the Institut de Radio Astronomie Millimetrique (IRAM) to study radio molecular spectra emitted from the vicinity of the twin stars. The scientists used these data to identify the raw materials for planet formation around V4046 Sagittarii - carbon monoxide and hydrogen cyanide - in the noxious circumstellar gas cloud.

"In this case the stars are so close together, and the profile of the gas - in terms of the types of molecules that are there - is so much like the types of gaseous disks that we see around single stars, that we now have a direct link between planets forming around single stars and planets forming around double stars," Kastner says.

Source: Harvard-Smithsonian Center for Astrophysics (news : web)

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