Astronomy

Another planetary system is discovered

by David Cherry

Pennsylvania State University astronomer Alexander Wolszczan announced on April 22 the first confirmed discovery of planets beyond our solar system. The planets, orbiting a pulsar rather than a star, were first reported by Wolszczan and Dale Frail in early 1992. Since reports of extrasolar planets have been regularly followed by reconsiderations and retractions, it is this news of rigorous confirmation that counts.

Pulsars are much, much smaller than stars—18 miles across and less—and exceedingly dense and dark, but they typically emit a beam of light and/or radiowaves that sweeps the heavens as the pulsar spins on its axis with better than clock-like precision. It is commonly thought that pulsars are one kind of relic left behind when a star explodes in a supernova. That theory now seems open to doubt: How could planets survive such an explosion?

The existence of the three (and possibly more) planets orbiting pulsar PSR B1257+12 in the constellation Virgo is inferred from data obtained at the Arecibo radiotelescope in Puerto Rico that show systematic deviations in the timing of the pulsar's beam sweep (the beam flashes 160 times every second). The millisecond deviations are a result of the pulsar's slight wobble as pulsar and planets all orbit around their common barycenter (center of mass).

Presumably the intense beam makes life on a pulsar's planets impossible, so this interesting mode of discovery will not lead us to other Earths. But it encourages us to think that other Earths are out there orbiting stars, and we need only to develop means to detect them.

It isn't easy to obtain an image of a tiny planet drowned in the glare of its very close star. The planet's light must be detected as a tiny blip in a field several *billion* times brighter. There is also the less daunting problem of resolving or distinguishing two objects so close together even without glare. The preliminary step is indirect detection by measuring the star's tiny orbit (the "wobble" mentioned above) as all bodies in the system move around a common center of mass.

In our own solar system, it takes almost 12 years for Jupiter to make one orbit, and 29.5 for Saturn, so indirect detection requires repeated observations of candidate stars over years. Programs for detecting the wobble have been under way at telescopes of modest size for years, and the results have been promising, but not definitive.

Definitive results sought

To obtain definitive results, NASA has established ASEPS, Astronomical Studies of Extrasolar Planetary Systems, with a three-phase perspective. The first phase involves groundbased observations. The second relies upon an Earth-orbiting telescope specially designed and dedicated to this purpose. Of four candidate designs for the telescope, one is expected to be chosen at the end of this fiscal year, with launch possibly in 2004. The third phase—upon our return to the Moon—calls for building a large optical interferometer there to study the characteristics of the discovered planets. Interferometers receive wave fronts from different parts of the target and allow them to interfere to produce a fringe pattern, from which information about the target can be obtained.

Fred Vescelus at the Jet Propulsion Laboratory in Pasadena, California, program manager for ASEPS, explains, "Without a dedicated telescope, or a dedicated fraction of observing time on a telescope, it is difficult to put together a cohesive program that will run 5 to 15 years."

For the immediate, groundbased phase, NASA is negotiating for a share of the observing time of the W.M. Keck Observatory on Mauna Kea in Hawaii, by becoming a partner in the project. There, two 10-meter telescopes 85 meters apart—one already working, one being built—will sometimes operate together as an interferometer. Resolving power will be enhanced with adaptive optics to compensate for fluctuations in atmospheric refraction. The tremendous light-gathering power of a mirror of 10-meter diameter greatly increases the number of stars that can be studied by allowing the inclusion of relatively faint ones. This work might begin about 1997 or 1998. Five to fifteen years will be needed to record enough of the wobble orbit of a star to reliably infer the presence of a planetary system.

There is also a plan to build four 1.5-meter "outrigger" scopes near the two giants. They will work in concert with the giants, doing interferometric imaging. An interferometer must have at least three mirrors for imaging. Instead of inferring the presence of planets, Vescelus says, "with the outriggers, Keck will be able to directly image large, Jupiter-sized planets if there are any around very close stars." Instead of studying stars at intervals for years, two nights per star would tell whether this handful of closest stars has any Jupiters.

Right now ASEPS is building a prototype to test the interferometric approach it hopes to use with the Keck. Called Dual Object Interferometry, it was developed by the Jet Propulsion Lab's Michael Shao and will be applied in the infrared. The prototype, being built next to the 200-inch Hale telescope on Mt. Palomar, has the same baseline as the Keck, but much smaller mirrors—three of them. It should be working by next year.