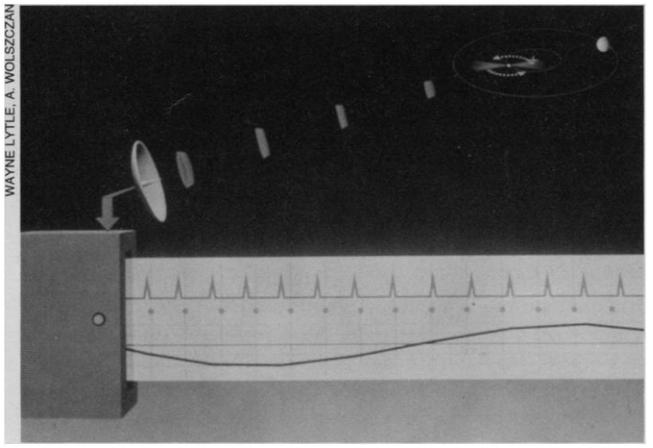
Have Astronomers Bagged A Pair of Pulsar Planets?

New observations strengthen the case for planets circling burned-out stars—and spur the search for an explanation

WHEN ASTRONOMERS IN ENGLAND announced last summer that they had discovered signs of a planet circling a burned-out stellar cinder known as a pulsar, reactions ranged from surprise to disbelief. How, astronomers wondered, could a planet have survived the apocalyptic supernova explosion that must have given birth to the pulsar? Now the skeptics may need to re-think their position. Another astronomer is reporting evidence of a pulsar with a planetary system—and this time it has a full retinue of planets.

"We have two for sure and more are quite probable," says Aleksander Wolszczan of Cornell University, who with his colleague Dale Frail of the National Radio Astronomy Observatory detected the second planetary system using the 305-meter radio telescope at Arecibo, Puerto Rico. The new findings, which Wolszczan described at this week's meeting of the American Astronomical Society in Atlanta and in a paper in the 9 January *Nature*, are spurring theorists to search for explanations of how such planets could possibly exist. And they are shaking up observers as well, for the new pulsar planets would be the first planets of any kind to be spotted outside the solar system. "We have indirect hints of planet-like objects around ordinary stars too, but none is confirmed," Wolszczan says.



WAYNE LYTLE, A. WOLSZCZAN

Watching the clock. *A planet orbiting a pulsar tugs the star back and forth, varying the timing of its pulses.*

That doesn't necessarily mean that planets are more common around pulsars than around ordinary stars. It's just that pulsar companions may be far easier to detect, thanks to the clocklike radio pulses emitted by pulsars. The new planets and the earlier one both show up as slight inconsistencies in the radio pulses, which are emitted in sync with the host pulsars' rotation. A planet influences the pulses because it exerts a gravitational pull on its host, tugging it to and fro. The result is a Doppler shift in the signal, evident as a periodic change in the pulses' timing. Detecting planets by this strategy, says Wolszczan, "is 1000 times more accurate than any visible astronomy technique."

When Andrew Lyne and his colleagues at the Nuffield Radio Observatory in England announced last summer that they had observed just such a shift in the signal of a pulsar, occurring on a regular, 6-month period, they interpreted it as the signature of an Earth-sized planet (*Science*, 26 July 1991, p. 385). But the finding was controversial. Some astronomers dismissed the effect as some fluke caused by the wobbling of the pulsar itself or even by Earth's motion around the sun. A few, however, including Stan Woosley of the University of California, Santa Cruz, took a stab at reconciling the existence of a planet with the pulsar's violent birth process. In Woosley's scenario the planet didn't exist before the explosion; instead it condensed from the debris.

Such a planet would be nothing like our own. A pulsar, being the dead remnant of a star, doesn't shine with benign visible light. Instead, its main energy output takes the form of a fierce stellar wind, which would blast any planet with particles traveling near the speed of light. The heavy dose of radiation might make the surface quite inhospitable—something like that of Mercury, Wolszczan guesses.

Now, these uninviting worlds seem to be multiplying. Wolszczan has seen a more complicated pattern of Doppler shifts in a second pulsar's signal. So far, he has identified the signatures of two bodies with masses at least 2.8 and 3.4 times that of Earth, completing orbits about the size of Mercury's every 98 and 67 days, respectively. And he thinks evidence of still more planets may be lurking in the signal.

Lyne welcomes the company for his original pulsar planet. The new findings, he says, make it harder to dismiss either report as an artifact. Wolszczan's observations may also make pulsar planets more plausible by suggesting another way they could have formed: with the help of a companion star, which would have supplied the raw material for a planetary system.

Evidence for a companion star comes from the new pulsar's spin rate, indicated by the frequency of its signal. Whereas Lyne and his colleagues listened in on a run-of-the-mill pulsar that spins about once a second, Wolszczan's pulsar spins hundreds of times each second. Current thinking holds that such millisecond pulsars aren't born spinning at that rate. Instead they get sped up sometime in their old age when a companion star swells and dumps material onto their surface.

That same process could spawn planets if it ran amok, says Johns Hopkins University astronomer Julian Krolik. As the companion star lost mass to its pulsar partner, the companion might become unstable and completely vaporize. The cloud of dust would then spread out and condense into planets.

Woosley agrees that the new pair of planets probably represents the legacy of a now-vanished companion star. But he maintains that supernova debris is a more likely explanation for Lyne's original pulsar planet. Krolik, though, thinks that a companion star could account for the original pulsar planet as well. When that sighting was first published, he suggested that the planet might have started out as a companion star that got whittled down to planet-size as the pulsar fed off material from its unfortunate partner, which never had the mass to spin the pulsar up to a millisecond rate.

All that may sound farfetched, but Krolik points out that the conditions he and other theorists are invoking to explain the planets have already been documented for other pulsars. Observers have found dozens of examples of pulsars with ordinary stellar companions, and even one "black widow" pulsar, apparently in the process of consuming its mate. "What's going on [in the formation of these planets] is that a variety of effects we're already familiar with are taking place," says Krolik. If so, Wolszczan speculates, the universe may be pulsing with pulsar planets. ■ FAYE FLAM