Radio Pulses Hint at Unseen Planets

Amid radio signals emitted by a pulsar lying a mere 1,600 light-years from Earth, two U.S. astronomers have found evidence that two, or possibly three, unseen planets may orbit this dense, rotating star. Their report comes less than six months after astronomers at the University of Manchester in England announced that they had inferred the existence of a planet-like mass orbiting another Milky Way pulsar (SN: 7/27/91, p.53).

If further studies indicate that planet-like objects routinely form around pulsars, "we may be beginning [to uncover] a whole new branch of astrophysics," says Aleksander Wolszczan of the Arecibo Observatory in Puerto Rico, who made the new pulsar finding.

He and Dale A. Frail of the National Radio Astronomy Observatory in Socorro, N.M., who conducted follow-up observations of the pulsar, detail their work in the Jan. 9 NATURE.

Wolszczan made his initial discovery in February 1990, during a seemingly inopportune observing session at Arecibo. With support equipment shut down for routine maintenance, the observatory's radiotelescope lacked the ability to do long-term tracking of astronomical targets. Nonetheless, the astronomer managed to find two previously undiscovered millisecond pulsars — compact objects, known as neutron stars, that rotate thousands of times per second.

Radio emissions from one of the pulsars, called PSR1534+12, have helped to verify key predictions of Einstein's general theory of relativity, Wolszczan and several coauthors note in a separate article in the Jan. 9 NATURE. The other pulsar, PSR1257+12, is proving at least as intriguing, thanks to quasiperiodic fluctuations in the arrival times of radio waves emitted by this resident of the Virgo constellation.

Normally, millisecond pulsars flash like lighthouse beacons, beaming radiation toward Earth at regular intervals. But some of the radio waves emitted by PSR1257+12 reach Earth about three thousandths of a second sooner than predicted, while others arrive about three thousandths of a second later than expected. This suggests that the pulsar wobbles in space — sometimes moving slightly closer to Earth and sometimes receding slightly — in a nearly periodic fashion.

What might cause this peculiar wobble? Wolszczan and Frail assert that the gravitational tug supplied by unseen planets orbiting the pulsar best explains the motion.

After analyzing some 4,000 radio signals from the pulsar, recorded during the past 18 months at Arecibo, the two researchers conclude that one of the proposed planets would orbit the pulsar at a distance of about 53,800,000 kilometers, with an apparent orbital period of 66.6 Earth-days. The other would orbit at around 70,300,000 kilometers, with a period of 98.2 Earth-days. Each body would have a mass roughly three times that of Earth, Wolszczan and Frail assert.

A slight extra wobble in the pulsar — which the researchers detected by comparing the Arecibo data against observations made with the Very Large Array radiotelescope near Socorro — suggests that a third planet may orbit the pulsar. This object would resemble Earth in terms of period, mass and orbiting distance, Wolszczan says.

He and Frail say they have ruled out "star quakes" — motions originating within the pulsar — as an explanation for the wavering radio signals. Some researchers have suggested that star quakes might explain the far simpler, perfectly periodic wobble in the pulsar described by the Manchester team last summer. But star quakes can't easily produce the complex, quasiperiodic variation in the radio pulses emitted by the newly discovered pulsar, Wolszczan says. And while a youthful quake or two might occur in the previously described pulsar, only a few million years old, the more recent discovery — about 100 times older — would likely undergo little internal motion, he adds.

The new work "adds credence to the whole notion that some pulsars have planets," says Stanford E. Woosley of the University of California, Santa Cruz. "Probably almost everyone will now believe that there are objects orbiting some pulsars having masses comparable to terrestrial planets."

Furthermore, he says, if pulsar-orbiting planets can form — possibly representing the remnants of a massive companion star that might have once whirled around the pulsar — then it's likely that asteroid-sized objects also form, and even slam into the star. And if such jolts were to occur routinely in pulsars throughout the cosmos, they might generate bursts of gamma rays that could account for the energy and distribution of bursts recently detected by the orbiting Gamma Ray Observatory (SN: 9/28/91, p.196), Woosley maintains.

Although these musings remain speculative, Wolszczan says radio studies conducted over the next two or three years should provide a test of the planet theory. If the planets exist, their gravitational interactions with the pulsar will alter its radio signals during that time in a predictable and highly testable fashion, he says. *— R. Cowen*

Witnessing the birth of a radio supernova

Supernova 1987A is on the air again with a new, intriguing radio message. After a lengthy interval of quiet following a brief, initial outburst of radio waves associated with the violent explosion of a blue supergiant star, the region surrounding the star's remains has resumed emitting at radio frequencies.

Radio astronomers in Australia first detected these renewed — but then faint — signals in the summer of 1990, more than three years after the initial explosion. Since then, the signals have grown stronger, but this increase in intensity has occurred unevenly across the monitored frequencies.

"This is the first time the birth of a nearby radio supernova remnant has been witnessed, and future observations will allow the structure of the remnant to be compared with the many other known radio remnants," researchers at the Australia Telescope National Facility and the University of Sydney write in the Jan. 9 NATURE.

The stellar explosion that created supernova 1987A generated prodigious amounts of electromagnetic radiation over a wide range of wavelengths. It also hurled vast quantities of matter — electrons and ions — into space.

Astronomers expected the impact of the ejected material, traveling at roughly one-tenth the speed of light, to cause tremendous shock waves in any gas clouds surrounding the exploded star. This interaction would accelerate electrons to nearly the speed of light. As these relativistic electrons spiraled down magnetic field lines in a cloud of gas, they would emit radio waves at particular frequencies.

The fact that radio waves from supernova 1987A remained undetectable at the monitored frequency of 843 megahertz until July 6, 1990, and at higher frequencies until Aug. 16, 1990, suggested the absence of gas clouds in the region immediately surrounding the central object. This scenario fits with the notion that a fierce stellar wind from the blue supergiant had scoured out the region just before the star finally exploded. Radio emissions resumed when ejected material eventually encountered sufficiently dense clumps of gas.