

Growing Proof of Other Worlds Out There

By JOHN NOBLE WILFORD

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After so many ephemeral promises of stunning discovery, here today and then explained away, scientists now feel sure that they have unqualified proof of the existence of other planets far beyond the solar system.

New, more precise observations have at last convinced a growing number of astronomers that such a planetary system has been found about 1,500 light-years away in the Virgo constellation, and this time the phenomenon is for real.

The skepticism and caution that greeted the first report of the discovery more than two years ago have given way to confident statements emblazoned with words scientists seldom use, like "unambiguous," "irrefutable" and "complete confirmation."

The discovery means that scientists have long suspected but could not establish, the Sun and its retinue of orbiting bodies are not

Astronomers Feel Sure Newly Found Planets Orbit Around Pulsar

unique in the universe. And if there is more than one planetary system, it stands to reason that there are countless more worlds out there. This increases the possibility that some of them could harbor life, although the newly discovered planets are almost certainly inhospitable to life.

In a report being published today in the journal *Science*, Dr. Alexander Wolszczan, an astronomer at Pennsylvania State University, said the new radiotelescope evidence confirmed earlier clues that two planet-size objects are orbiting a pulsar — not an ordinary star like the Sun, but a dense, rapidly spinning remnant of an exploded star,

its thermonuclear furnace dead. A third planet, about the size of Earth's Moon, was also detected, and others may be revealed through further observations.

The objects, being too small and too far away for current optical telescopes, have not been detected in visible or infrared light. But the pulsar's radio signals, flashing at a rate of 160 pulses a second, have been received and recorded by the giant Arecibo radio telescope in Puerto Rico. A careful analysis of these faint signals gave astronomers the evidence they needed to confirm their first conclusion that variations in the signals reflected the presence of at least two large planets.

As theorists had predicted, the two planets in their separate orbits perturb each other gravitationally, and these disturbances cause a subtle pattern in the wobble of the

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pulsar's spin. The pulses of these fast-spinning dead stars are so precise that they resemble the ticking of the most accurate atomic clock. Any regular variation in that ticking could indicate the presence of more than one planet around the pulsar.

Dr. Wolszczan said the low-level, nonrandom fluctuations in the pulsar's radio signals "constitute a final proof that the first extrasolar planetary system has been unambiguously identified."

Other Astronomers in Assent

In a telephone interview, Dr. Wolszczan said he was a cautious person but felt entirely comfortable with his bold interpretation. What was a hypothesis when he reported the initial observations in January 1992, he said, is "not a hypothesis any longer," adding, "What I have is the proof that we can indeed say planets have been discovered outside the solar system."

Other astronomers and theoretical astrophysicists familiar with the research have been won over.

Dr. Frederic Rasio, an astrophysi-

cist at the Institute for Advanced Study in Princeton, N.J., agreed that the observation amounted to a "complete confirmation" of the planet discovery. "I can't conceive of anything else, other than two planets, that would mimic these results," he said.

Dr. Stephen Thorsett, a pulsar specialist at the California Institute of Technology in Pasadena, said the research was "very solid and very exciting" and has other astronomers examining other pulsars for possible signs of other planetary systems. "I think we're all convinced," he said, although it may take direct observations in the form of pictures to persuade some holdouts.

Unusual Radio Signals

In the summer of 1991, Dr. Wolszczan and Dr. Dale A. Frail, a researcher at the National Radio Astronomy Observatory at Socorro, N.M., detected unusual radio signals coming from the pulsar, designated PSR B1257+12. This is a type of neutron star, the collapsed core of a star that exploded a billion years ago. Like all neutron stars, it is extremely dense, with a mass about 1.4 times that of the Sun, but a diameter of no more than 12 miles.

Analyzing variations in the signals,

the scientists inferred that two or more objects were exerting a disturbing gravitational influence, causing the pulsar to wobble slightly but regularly. They used the pulses to determine that one planet is 3.4 times Earth's mass and orbits the neutron star once every 66.6 days. The other is 2.8 times Earth's mass, with an orbital period of 98.2 days.

The new observations confirmed these estimates and also detected the Moon-size planet with a 25.3-day orbit, much closer to the neutron star. Indeed, as a sort of small-scale version of the inner solar system, all three objects travel about the neutron star within the range of the orbit of Mercury around the Sun.

"The physics and chemistry of the planets may be very different compared to Earth," Dr. Wolszczan said, "but the dynamics aren't."

Concern for Confirmation

Even before Dr. Wolszczan made the initial announcement, Dr. Rasio and other theorists suggested a method for confirming the existence of planets around the pulsar. Their concern for confirmation was appropriate because a previous report the year before of a planet detected around a pulsar was soon retracted as a mistake.

The first clues for the Wolszczan discovery were based on the gross gravitational perturbations of the planets' mass on the pulsar's spin. In addition, Dr. Rasio and others calculated that the pull of the two planets on each other should significantly alter their orbits on a regular basis. The effect of these changing orbits on the pulsar's wobble should be detectable in the arrival times of the radio pulses.

The astronomers said they had also picked up hints of a Jupiter-size planet farther out from the pulsar, but it may take several more years to confirm that.

One of the most exciting implications is that the discovery was made not at a Sun-like star but at a pulsar, the ruin of cataclysmic violence.

"If pulsars have planets," said Dr. Thorsett, the specialist at Pasadena, "then almost anything can."