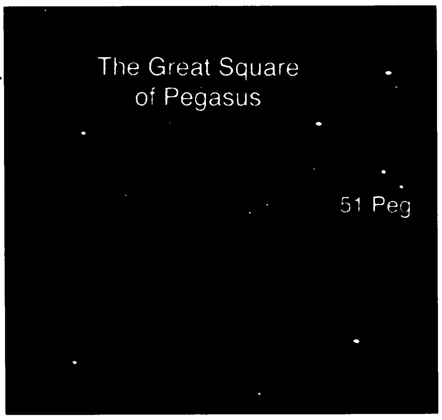
Finding Planets Around Ordinary Stars

The news flashed through the astronomical community like a lightning bolt: Astronomers have found two examples of planets orbiting ordinary stars that lie close to our sun.

At a meeting on low-temperature stars 2 weeks ago in Florence, Michel Mayor and Didier Queloz of Geneva Observatory reported strong evidence that a planet almost as massive as Jupiter orbits a familiar, sunlike star a mere 42 light-years from our solar system. The finding represents the first time that astronomers have inferred the presence of a planet orbiting a star similar to our sun. Earlier, researchers had detected planets around a pulsar, an extremely dense, rapidly spinning star that emits radio waves (SN: 3/5/94, p.151).



J. Seevers/Adler Planetarium & Astronomy Museum

New evidence indicates that an unseen planet circles the star 51 Pegasi.

"It's a big, big step," says J. Roger Angel, director of the Steward Observatory Mirror Laboratory in Tucson.

Circling the star 51 Pegasi at just one-twentieth the distance of Earth from the sun, the newly discovered planet is lost in the glare of its bright parent star. No telescope can image it. Only a tiny wobble in the motion of 51 Pegasi, monitored over a 2-year period with a visible-light spectrograph at the Observatoire de Haute Provence in Saint Michel, France, betrays the gravitational tug of the massive planet. The planet revolves around the star, a resident of the constellation Pegasus, once every 4.2 days, causing the periodic wobble.

Last week, Geoffrey W. Marcy and R. Paul Butler, both of San Francisco State University and the University of California, Berkeley, observed the orbit of 51 Pegasi for four nights with the Lick Observatory's 3-meter telescope on Mount Hamilton in California. Marcy told SCIENCE NEWS that he and Butler detected virtually the same wobble as the Swiss team.

"I have no doubt at all about our result, but it's nice to have the external confirmation to convince other people," says Mayor. Adds Marcy, "We're excited that one of the most compelling questions in astrophysics [whether any planets orbit sunlike stars] has been answered."

That confirmation leaves other questions open. Some astronomers have wondered how a planet with roughly the mass of Jupiter can survive so close to a star nearly as hot as the sun. Adam S. Burrows of the University of Arizona in Tucson calculates, however, that even if the planet were mostly gas, like Jupiter, its gravity would prevent 51 Pegasi from boiling away the material. Nonetheless, the star's heat may have caused the planet to swell. It remains unclear whether the planet formed at its current location or the star dragged it in from a more distant orbit.

As if one finding wouldn't suffice, a second discovery has kept planetary scientists abuzz. At the Florence meeting, astronomers described near-infrared images and spectra of an object about 20 times the mass of Jupiter circling the tiny star GL229, located 30 light-years from Earth.

The finding, based on observations with several telescopes at Palomar Observatory near Escondido, Calif., differs in several respects from that announced by the Swiss team. GL229 has about four-tenths the mass of the sun, and the planetlike object it harbors orbits much farther away—about 44 times Earth's distance from the sun, says co-investigator Shrinivas Kulkarni of the California Institute of Technology in Pasadena.

Kulkarni and his colleagues, including Ben Oppenheimer and Tadashi Nakajima, also of Caltech, note that the massive body could be either a planet or a brown dwarf—an object that forms as stars do but lacks the mass to sustain nuclear burning (SN: 9/23/95, p.200). "It's not clear exactly what the boundary [in mass] is between a planet and a brown dwarf," notes Kulkarni.

The presence of methane in the object's spectra has grabbed the attention of astronomers. If the body were a star, its intense heat would have destroyed the methane. "To my mind, the big difference [between this and previous brown dwarf candidates] is the apparent presence of methane," notes Jonathan I. Lunine of the University of Arizona. Other candidates, he says, are much more massive and straddle the line between star and brown dwarf. "It's been a long struggle to find a brown dwarf, and this is the clearest example," says Burrows.

—R. Cowen

Electric signals may herald earthquakes

After years of intense skepticism, U.S. researchers are starting to take more seriously the work of a Greek physicist who claims to make successful earthquake predictions by detecting electric signals from the ground.

"We became so intrigued because we just can't dismiss it," says seismologist Thomas V. McEvilly of the University of California, Berkeley, who organized a workshop in Berkeley last week to discuss electromagnetic methods of predicting quakes.

The meeting focused on the work of Panayiotis Varotsos, a solid-state physicist at the University of Athens and a lightning rod in the field of earthquake research. In 1983, Varotsos and two colleagues started setting up observation stations in Greece to catch potential quake precursors, using a technique called the VAN method. He claims to have predicted 10 of the 14 strong earthquakes that have hit Greece in the last 9 years, including three powerful shocks this summer.

The recent tremors caught the attention of McEvilly and U.S. scientists because Varotsos faxed his predictions to 29 institutes outside Greece before the quakes hit on May 4, May 13, and June 15. The last one caused considerable damage and killed 26 people.

The predictions impressed some researchers, such as physicist Antony C. Fraser-Smith of Stanford University, who studies electromagnetic activity in California in hopes of detecting prequake changes. "I'm not sold on the VAN method, but [Varotsos] is becoming much more credible. Although he didn't hit the earthquakes exactly right, he was close," says Fraser-Smith.

Varotsos has set up stations at seven locations known to be sensitive to prequake changes in Earth's electric field. According to Varotsos, rocks subjected to increasing stress will release electric signals weeks before they fracture during a quake. Each station responds only to particular geographic regions. When a station catches an unusual electric signal, Varotsos says, he can identify the likely epicenter of the upcoming shock.

Detractors reject Varotsos' claims of successful predictions. "I think the whole thing is a waste of time," says David D. Jackson of the University of California, Los Angeles.

Jackson and Yan Kagan performed a statistical test of Varotsos' predictions between 1987 and 1989. They compared the VAN method to one that predicts earthquakes at random, given the constraint that tremors tend to cluster together. "The test shows that the VAN technique does not do a better job of predicting than would random predictions."

Jackson and others criticize Varotsos for issuing overly vague predictions of time and location, making it difficult to verify whether they have actually come true. Varotsos has also come under fire for his speculative physical theory that explains the origin of the electric emissions and why such signals reach only certain sites.

Despite the objections, Varotsos has convinced some earthquake experts to explore the method further. Seiya Uyeda, a seismologist at Texas A&M University in College Station and at Tokai University in Shimizu City, Japan, helped launch a VAN-type program in Japan (SN: 12/18&25/93, p. 407).

U.S. researchers lack the funds to run such a program, but Fraser-Smith and several other scientists expect to step up their own ongoing studies of electromagnetic signals in California. If its fiscally squeezed budget allows, the U.S. Geological Survey plans to spend $150,000 to $200,000 on such studies next year, says Evelyn A. Roeloffs of the USGS in Vancouver, Wash. U.S. scientists will also collaborate with Varotsos in Greece to explore how his method works.

Researchers have had only modest success in detecting electromagnetic signals before U.S. earthquakes. In 1989, an instrument run by Fraser-Smith for atmospheric studies accidentally captured changes prior to the destructive quake south of San Francisco. Since then, he has set up monitoring equipment along the San Andreas Fault at Parkfield, Calif., where seismologists expect a strong earthquake. His instruments did register some activity prior to a magnitude 5 shock in late December.

— R. Monastersky

Lepton physics work attracts Nobel honors

Along with the electron and muon, the tau particle and three varieties of neutrinos are now firmly established as members of the lepton group of subatomic particles. This year's Nobel Prize in Physics, announced last week, honors two physicists who played key roles in experiments demonstrating the existence of these constituents of matter.

Frederick Reines of the University of California, Irvine, contributed to the discovery of the neutrino in the 1950s, while Martin L. Perl of the Stanford (Calif.) Linear Accelerator Center (SLAC) was a member of the research team that identified the tau lepton in the 1970s.

The neutrino originated as a hypothetical particle, invented in 1930 by Wolfgang Pauli to account for some missing energy when a radioactive atomic nucleus emits an electron. To uphold the law of conservation of energy, he proposed the existence of an uncharged subatomic particle that accompanied the electron and interacted very little with other forms of matter.

Subsequent theoretical developments bolstered the credibility of Pauli's hypothesis, but most physicists despaired of detecting such an elusive particle.

Realizing that nuclear reactors could serve as intense neutrino sources, Reines, working with Clyde L. Cowan Jr., set up an experiment to find neutrinos by looking for the rare instances in which a certain kind of neutrino collides with a proton (in water) to create a neutron and positron. They eventually accumulated enough experimental data to prove the existence of the neutrino as a free particle. Cowan died in 1974.

That year, Perl was finding hints in the debris of collisions between high-energy electrons and positrons of a hitherto undiscovered lepton. Although some theorists had suggested that heavy leptons exist, no one was certain that any would be found (SN: 9/12/92, p.174).

After more than a year of data analysis, Perl persuaded his coworkers at the Stanford Positron-Electron Asymmetric Ring (SPEAR) particle collider that they were truly observing a new and different type of elementary particle. He dubbed it the tau.

About 3,500 times heavier than the electron, the tau lepton is a member of the same family of subatomic particles as the top and bottom quarks (SN: 7/1/95, p.10).

— I. Peterson

SLAC

Martin Perl (center) meeting in late 1974 with Gerson Goldhaber (left) of the Lawrence Berkeley (Calif.) Laboratory and Burton Richter (right) of SLAC in the control room of the SPEAR collider, where the tau lepton was discovered.

Child's bones found in Neandertal burial

The infant's delicate skeleton lay on its back, arms extended and legs bent upward, at the bottom of a 5-foot-deep pit someone had dug perhaps 50,000 to 70,000 years ago. A limestone slab nudged against the top of the child's skull, and a small, triangular piece of flint rested at about the spot where the tot's heart had once beat.

A team of Japanese and Syrian scientists unearthed the prehistoric youngster in a cave at Dederiyeh, a site located near the Syrian city of Aleppo. They consider the skeleton to be that of a Neandertal and call the discovery the best evidence yet of Neandertal burial practices.

"This child was no more than 2 years old, and its anatomical features are clearly those of a Neandertal," asserts excavation director Takeru Akazawa, an anthropologist at the University of Tokyo.

Akazawa and his coworkers uncovered the infant's skeleton in August 1993. They describe the find in the Oct. 19 NATURE.

Dating of animal teeth and burnt flint from sediment associated with the child's skeleton, based on separate techniques for assessing the accumulation of radioactivity in buried objects, is now under way.

The Dederiyeh infant evidences much the same anatomy as the 60,000-year-old partial skeleton of a Neandertal baby discovered in an Israeli cave, Akazawa holds (SN: 1/1/94, p.5). Key Neandertal features include a bony ridge at the back of the skull, a sloping face, a wide, protruding nose, receding cheeks, and a chinless jaw.

Stages of tooth eruption and development in the specimen indicate that the infant had reached no more than 2 years of age, Akazawa contends. However, the width of the braincase roughly matches that of the average 6-year-old in modern Japan, suggesting that the Dederiyeh infant had a relatively large brain for its age, he asserts.

The skeleton came from soil that has also yielded flaked stone artifacts resembling those found at Israel's Kebara cave, another Neandertal site. Akazawa supports the theory, proposed in 1992 by Ofer Bar-Yosef of Harvard University, that the tool-making styles of modern humans who reached the Middle East from Africa about 100,000 years ago are distinct from those of Neandertals who fled a frigid Europe for the Middle East around 70,000 years ago.

Bar-Yosef and other researchers from around the world will meet with Akazawa in Tokyo this November to discuss the implications of the Dederiyeh discovery.

— B. Bower