

Pulsar clock to set cosmology by

Late in 1982 the discovery of a pulsar that pulses 642 times a second, 20 times as fast as the fastest pulsar known before then, caused a sensation among astronomers (SN: 1/1/83, p. 4). This milli-second pulsar (so called from its 1.6-milli-second period) has been closely watched ever since. An analysis of its data recorded between Nov. 28, 1982, and October 12, 1984, now leads four astronomers to call it the most accurate clock in the sky, competitive over periods of months with the best atomic clocks. In the June 13 NATURE, the observers say the pulsar, catalogued as PSR1937+21, will be useful as a timing beacon for navigation and geodesy and for tests of theories of cosmology.

To bring out the pulsar's qualities as a timekeeper, the astronomers had first to subtract out a known slowdown rate. All known pulsars are slowing down, but, unlike the others, PSR1937+21 has never yet shown a glitch or "starquake," a sudden discontinuous speedup in pulse rate, after which the slowing down resumes. It is on PSR1937+21's continued glitchless performance that its prospects as a timing beacon depend.

Two years of glitchless operation have enabled Michael M. Davis of the Arecibo (Puerto Rico) Observatory, Joseph H. Taylor of Princeton (N.J.) University, Joel M. Weisberg of Carleton College in Northfield, Minn., and Donald C. Backer of the University of California at Berkeley to determine the pulsar's pulse period to an accuracy of 16 decimal places and its position to a hundred-thousandth of a second. With such accuracy it can be used in connection with atomic clocks for navigation, geodesy and more accurate calculation of the earth's position in space.

The pulsar's cosmological use depends on its expected interaction with gravitational radiation. Such radiation is gravity's analog to electromagnetic waves such as radio. As radio waves come from electric and magnetic disturbances, so gravitational waves (which have never been observed directly) are expected to come from gravitational disturbances, and some of those disturbances could represent important events in the history of the universe. Passage of such waves should disturb the pulsar.

So far no such disturbance has been seen, and the observers thus rule out a suggestion of certain cosmologists, that there is a background of gravitational waves pervading the universe and carrying sufficient energy to close the universe. However, other, less energetic gravity signals may still be found. So far the pulsar data can rule out only waves with periods up to one year; a longer term of observation will be necessary to rule out (or establish) longer periods. —D. E. Thomsen

Quasar found in galaxy cluster

For the first time in two decades of observing quasars, astrophysicists have found a quasar in the middle of a rich cluster of galaxies, a place where a lot of them have wanted to find one. The bright object (arrow) is the quasar 3C275.1. The others are galaxies.

A popular theory of what quasars are says they are things that happen in the nuclei of galaxies, that is, they are particularly active galactic nuclei. Galaxies characteristically appear in clusters. If quasars are active galactic nuclei, objects to the theory inquire, how come no quasar has ever been seen in a cluster of galaxies? This photograph shows one.

The quasar in the picture is surrounded by a nebulousity that observers first thought was a galaxy. However, spectrographic studies done at Kitt Peak National Observatory in Tucson, Ariz., show that it is a gas cloud 300,000 light-years across. In the view of most theorists, the engine that produces a quasar's great energies



centers on a black hole. This cloud could be matter drawn to the black hole out of the intergalactic medium of the cluster. The quasar and cluster are about 7 billion light-years away; the faintest objects in the picture are 10 million times fainter than the faintest stars visible to the naked eye. Paul Hintzen of NASA's Goddard Space Flight Center in Greenbelt, Md., and John Stocke of the University of Arizona at Tucson made the picture.

Army aerosol laboratory

In the face of the recent court decision that the U.S. Army had not adequately assessed the environmental impact of a proposed toxin-testing facility at Dugway Proving Ground in Utah (SN: 6/8/85, p. 359), the Army has decided to prepare a full environmental impact statement. It decided neither to appeal the court decision nor to rewrite the less extensive environmental assessment intended to demonstrate that no environmental impact statement would be necessary. Jeremy Rifkin of the Washington, D.C.-based Foundation on Economic Trends, a plaintiff in the court case, says he is happy with the Army's decision because the preparation of a formal environmental impact statement opens the project plans to comment by other federal agencies and by the public.

The Army plans to use the Dugway Proving Ground to assess the military value of chemical warfare and biological defense systems. Army spokesperson Lt. Col. Craig Mac Nab says, "The [other] modernization at Dugway is proceeding, but we do need this aerosol test laboratory." The proposed laboratory was designed to meet the safety requirements for work with genetically engineered microbes, although the Army says it currently has no such plans. "We are disappointed [with the court decision] because of the delay," Mac Nab says. A timetable for preparing the environmental impact statement is currently being set up; Mac Nab says the statement will be prepared on "an expedited schedule." □

Chem-weapons ban ends

A 16-year moratorium on U.S. chemical weapons production ended last week when the House of Representatives voted to authorize \$124.5 million to produce a new form of nerve gas two years from now. Last month, the Senate approved a similar measure. The new "binary" weapons are chemicals that become toxic only after being mixed on or near the battlefield, shortly before use.

The Reagan administration has been lobbying hard for more than four years to win funding for these new weapons. In arguments on the House floor June 19, Samuel Stratton (D-N.Y.) countered arguments that the weapons were unnecessary with quotes from a letter Defense Secretary Caspar Weinberger had drafted earlier in the day: "The current [chemical weapons] stockpile does not represent a credible retaliatory capability," he said. "While it is true that we plan on having a smaller, safer and effective binary stockpile, we do not mean to imply that the old munitions are adequate.... [W]e have less than one-third of the nonpersistent nerve agent artillery munitions required for deterrence, and even that inadequate quantity is seriously flawed in safety, logistical and employment characteristics."

John Edward Porter (R-Ill.), who authored the amendment that would have continued the nerve-gas production ban, said his opposition centered largely on what it would cost to produce these weapons and destroy those they made obsolete — a figure he said defense experts estimated would approach \$20 billion. □