NEW PULSAR PROBLEMS

Glitch and antiglitch

Univ. of Calif.

Pulsar timers: Hills, Nelson, Wilson.

Pulsars were once considered accurate timekeepers. When they were first observed the repetition of their pulses appeared to be extremely exact. But after some months of observation it became clear that the pulse rates were gradually slowing down.

Then about a year and a half after pulsars were first reported, it appeared that for two of them at least the gradual slowdown was occasionally punctuated by jerks, sudden speedups, after which the slowdown resumed. These were called sudden events, or glitches, a word borrowed from the jargon of the astronauts.

Now it appears from observation of the only known optical pulsar, NP 0532 in the Crab nebula, that in addition to the speedup sort of sudden event, it is subject to the reverse variety: sudden slowdowns in pulse rate. And unlike the speedups, the antiglitches are hard to explain.

The slowdowns were discovered by a group from the University of California, graduate students Jerry Nelson, Richard Hills and Chris Wilson of the Berkeley campus, Dr. David Cudaback of the Berkeley campus and Dr. Joseph Wampler of the Lick Observatory and the Santa Cruz campus. Electronics for the experiment were built by John Sarloos of Lawrence Radiation Laboratory, and the telescope was operated by Remington Stone of Lick Observatory.

The observations timed the arrival of light pulses from the pulsar at the telescope using a portable atomic clock. From these data, changes in the arrival time due to motion of the earth were discounted.

In order to correct for the earth's motion, which is affected not only by the sun but also by the other planets, the observers used a very accurate ephemeris, or table of planetary positions, derived by the Jet Propulsion Laboratory of California Institute of Technology. They needed an accuracy of a few millionths of a second in the time measurements, and the ephemeris gave them the motions of the planets to an equivalent accuracy—the distance light goes in that time, a few thousand feet.

When this had been done, a comparison between the data and the change in arrival time that was expected from the previously observed slowdown of the pulsar's pulse rate showed that in at least two cases, and possibly a third, the arrival of the pulses was off the expected time by 100 millionths of a second. "I'm pretty confident that this represents a slowdown in frequency," says Dr. Cudaback.

So far the researchers do not know whether similar slowdowns occurred in the pulsar's radio pulses. That would be expected if the pulsar's pulsations are caused by rotation, as theorists claim. The California group deliberately avoided communication with other observers of the pulsar during the period of their observations so that their interpretations would not be influenced by anyone else's reports. Now that they commit themselves to a claim of independently observing the slowdowns, they are beginning to look for corresponding radio events. "We are just very vaguely beginning to compare ideas," says Dr. Cudaback.

The light pulses of the pulsars are about two-thousandths of a second wide, and the California observers' ability to time their arrival within a small fraction of the pulse width depends on the great regularity of the pulse shapes. The radio pulses, in contrast, vary a great deal in height and shape, and it is not certain whether they can be timed well enough to discover a 100-microsecond difference.

In contrast to the sudden speedups in pulse rates, which could be explained theoretically, no explanation of the sudden slowdowns is yet forthcoming from pulsar theorists. Some astronomers have elaborated a picture of what they call starquakes to explain the sudden speedups (SN: 6/27, p. 626).

In this theory the pulsar is seen as a neutron star with a solid outer crust. The gradual slowdown of its rotation is attributed to the braking effect of the energy it radiates. As the slowdown proceeds, centrifugal forces within the star become less and it tends to contract to a more spherical shape than it started with. This causes stresses in the solid crust, and periodically the crust readjusts suddenly. The effect of the sudden readjustments is to decrease the radius of the star, and when the radius of a rotating body decreases, the rate of rotation speeds up.

But to work a sudden slowdown into this kind of theory would require some sort of starquake that expanded the star, and this kind of sudden expansion does not fit with the theoretical picture of a neutron star that is gradually contracting. Exactly what theorists will come up with to explain the sudden slowdowns remains to be seen. □

CONTROLLED FUSION

Secret patent applications

Since 1958 the United States research program in controlled thermonuclear fusion has been declassified: There has been no secrecy about research results in the field. They have been open to anyone in the world who wanted to read about them, and progress has been an international affair, with Russians, Americans and Europeans all contributing their share (SN: 4/11, p. 373). Now, however, the Atomic Energy Commission has placed a secret classification on patent applications relating to a claimed new method for containing a thermonuclear plasma.

The central problem in controlled fusion research is devising a means for confining a hot plasma of ions and electrons for a long enough time so that the nuclei in the ions will begin to fuse with each other and produce energy. After two decades of disappointingly slow work, the last two years have seen a number of significant steps along the road to the proper containment of plasma reported openly and publicly by various laboratories in the Soviet Union, the United States, Great Britain and West Germany.

Now comes Dr. Keith Brueckner, a professor of physics at the University of California, San Diego, in La Jolla, and technical director of the private KMS Technology Center, who says he has worked out in theory a new way of containing plasma. He has made nine patent applications to the AEC with regard to his idea, and the AEC has classified the applications secret on the grounds that they have some possible military application.

Because of the security classification Dr. Brueckner may not discuss the technical aspects of his work, and the AEC will not. According to an AEC spokesman, classification of patent applications is not a routine precaution, and was done in this case because a possible military application was definitely seen. □