Puzzling pulsar offers opportunities

In announcing recently the first discovery of a pulsar in one of the globular clusters of stars that form a halo around our galaxy, Shrinivas R. Kulkarni of Caltech in Pasadena pointed out that it was not entirely unexpected. But the manner of its existing, as a millisecond pulsar alone — without a binary companion star — raises problems for the theory of pulsar formation. At the same time it offers opportunities for astronomers who study the globular clusters, which contain the oldest stars associated with our galaxy, for information about the evolution of the galaxy and various cosmological questions.

A pulsar is a neutron star, probably formed in the supernova explosion of an ordinary star. In the magnetized atmosphere of charged particles surrounding the neutron star, a spot produces a beam of radiation: radio waves, sometimes light, sometimes X-rays. The rotation of the star swings this beam around, giving an observer the effect of pulses.

Millisecond pulsars — those with pulse periods of a few milliseconds — are thought to develop out of a certain kind of binary star system that at first emits X-rays. Because these X-ray binaries are known to be in globular clusters, scientists have mounted a number of searches for pulsars in the clusters. In this one, Andrew G. Lyne and A. Brinklow of the University of Manchester, England, recorded multichannel radio data (that is, everything they could get) from the target globular cluster, known as Messier 28 or NGC 6628, with a 76-meter radiotelescope at the Nuffield Radio Astronomy Observatory at Jodrell Bank, England.

These data had to be searched for correlations revealing the presence of a pulsed signal. It took a supercomputer — a Cray computer at Los Alamos (N.M.) National Laboratory with a program developed by John Middleditch of Los Alamos, Donald C. Backer and Trevor R. Clifton of the University of California at Berkeley and Kulkarni. They found correlations pointing to a pulsed signal of 3 milliseconds period. Given this information, Lyne and Brinklow looked for a signal at that period and found it. The discovery was reported recently in Vancouver, British Columbia, at the meeting of the American Astronomical Society and the Canadian Astronomical Society and at a simultaneous meeting of the Royal Astronomical Society in England.

However, the new pulsar, now called PSR 1821-24, stands alone without a companion star. According to theory, a millisecond pulsar should not be able to spin so fast unless it has a companion from which it can draw matter and rotary motion and so increase its spin rate. Roger W. Romani, Kulkarni and Roger D. Blandford, all of Caltech, in a letter submitted to NATURE, propose two ways in which this pulsar might have come to stand alone.

Both take advantage of the dense packing of stars in globular clusters. In a globular cluster, 100,000 to 1 million stars are packed together in a volume small by astronomical standards. Close encounters between stars are statistically probable in a globular cluster, but virtually impossible in the more normal parts of the galaxy.

In one scenario the neutron star, which is the pulsar, formed alone. Through a close encounter it gained a red giant as a companion. In spinning up the neutron star, the red giant turned into a white dwarf. As the red giant lost more and more mass, the bond between it and the neutron star got weaker until finally a close encounter with a third star detached it.

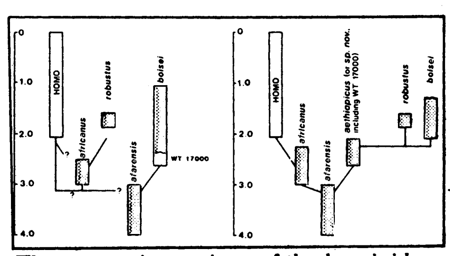
The second scenario has the neutron star hitting an ordinary star head on. The direct hit disrupts the ordinary star, and its material becomes a disc around the neutron star. The material in the disc gradually falls onto the neutron star and spins it up. After 10 million years the disc disappears.

In whatever way the origin of the millisecond pulsar in the globular cluster is explained, its presence will be a boon to people interested in globular clusters. By its precise timing they can track the motions of the globular cluster in space and so learn about its relation to the galaxy, possibly some of its history and so on.

The precise timing also may be of use to those interested in gravity waves. These are cyclic disturbances of gravitational forces that travel through space; another way of describing them is as ripples in the fabric of space-time itself. If such a wave passes by, stars and similar objects will move slightly, like chips on an undulating ocean. By comparing the timing rates of two or three millisecond pulsars, observers may be able to detect the passage of such a ripple.

— *D.E. Thomsen*

Hominid evolution: A tale of two trees



Delson/NATURE

The two main versions of the hominid family tree.

Paleoanthropologists are getting closer to a general agreement on the early branchings of the hominid family tree, says Eric Delson of the City University of New York. Several contending evolutionary trees have been whittled down to two main alternatives, he reports in the June 25 NATURE.

The two hypotheses emerged from a recent workshop on robust australopithecines, a group of hominids, or human-like creatures, that evolved at the same time as the lineage that led to modern humans, but became extinct around 1 million years ago. A volume of scientific papers from the workshop, which was attended by researchers from around the world (SN: 4/11/87, p.229), will be published next year.

Both evolutionary schemes maintain that fossils found at Hadar and Laetoli in Africa represent one species, *Australopithecus afarensis*, which dates to between 3.5 million and 3.1 million years ago and was near the common ancestor of all later hominids, says Delson. The "least contested" evolutionary tree holds that *A. afarensis* led in one direction to *A. aethiopicus*, a species that includes the recently discovered WT 17000 or "black skull" (SN: 1/24/87, p.58) and was either related to or a direct ancestor of the later robust australopithecines, *A. robustus* and *A. boisei*. In another direction, *A. afarensis* led to *A. africanus*, a species that has been found only in southern Africa, and then to the genus *Homo*.

The second hypothesis proposes that *A. boisei* includes specimens that have been labeled *A. aethiopicus*; that *A. africanus* led only to *A. robustus*; and that the ancestry of the *Homo* line is unclear.

One example of the emerging consensus is Todd R. Olson of City University of New York Medical School, who before the workshop held that *A. afarensis* was actually two species, a "robust" form leading to later robust australopithecines and a "gracile" form, including the partial skeleton called Lucy, which was on the *Homo* line. Olson says he now subscribes to the first hypothesis.

Proponents of the "two-species" interpretation are, however, not extinct. One paper from the australopithecine workshop, by Dean Falk of Purdue University in West Lafayette, Ind., suggests that Hadar hominids made up two species, while Laetoli specimens may have been still another species. Robust australopithecines in southern and eastern Africa were, in Falk's view, different races of the same species.

A key unresolved question, according to Delson, is the evolutionary role played by *A. africanus*, which "remains pivotal after more than 60 years of controversy."

— *B. Bower*