A STAR PULSATING 2000 TIMES A SECOND!

A group of astronomers (J. Middleditch of Los Alamos National Laboratory, C. Pennypacker and others of Lawrence Berkeley Laboratory, and others) have reported in the International Astronomical Union Circular No. 4735 the discovery on January 18, 1989, of an extraordinary star at the site of the supernova 1987A in the Large Magellanic Cloud in the southern sky. This star, discovered at optical wavelength, pulsates 1968 times a second and is the most rapidly pulsating star discovered so far. Understandably this discovery has aroused tremendous excitement.

A supernova represents the explosion of massive stars. Although this incredibly energetic phenomenon (the most spectacular event that Nature puts on) is a common one, the supernova of 1987 was one of the most important events in the history of astronomy, the reason being that it was the first nearby supernova since the advent of the astronomical telescope nearly 400 years ago. Because of its proximity, one can collect much more detailed information than has been possible till now.

According to our present theoretical understanding a supernova signals the birth of a highly condensed star. Such stars, made up almost entirely of neutrons, are called *neutron stars*. Their radii are only about 10 km, but their densities are in excess of 10^{14} g cm^{-3}. The first neutron star was discovered in 1968. Because they are very strongly magnetized the radiation from them is very strongly beamed, and because they spin very rapidly they act very much like a lighthouse. Consequently the energy radiated by these neutron stars comes to us in pulses—one pulse for every rotation. Hence such objects have come to be known as *pulsars*.

Nearly 500 pulsars have been discovered so far, all presumably associated with supernovae that occurred millions of years ago. The birth of the youngest among them—the pulsar in the Crab nebula—was witnessed and recorded in detail by Oriental astronomers in the year 1054 AD. Much of the present understanding of the properties of newborn pulsars is based on the observed properties of this 1000-year-old pulsar. Therefore it is understandable that astronomers all around the world were eagerly waiting to get a glimpse of the newborn pulsar in supernova 1987A. When it was finally unveiled about a month ago, everybody was startled!

The reason for this amazement is easy to understand. Yes, one did expect the infant pulsar to be spinning rapidly, but not 2000 times a second! According to our present understanding, a typical neutron star is about 1.4 times as massive as the Sun and it is very hard to reconcile how such an object can spin 2000 times a second without being completely disrupted by centrifugal forces. When such a new observation is made, there would necessarily be a rush of papers with many speculative suggestions. (We feel that journals should encourage such suggestions as this may lead to more experimental studies.) In fact Wang *et al*, in a preprint of a paper submitted for publication to *Nature*, speculate that the pulsation from this infant pulsar may be due to vibrations and not rotation. According to them, these vibrations will damp out in a few years and then one will begin to see a different kind of pulsar where the pulsations are due to rotation, as is commonly believed.

In a paper appearing in this issue of *Current Science* (p. 280) Bhattacharya and Srinivasan have analysed the implications of the very rapid pulsations on the assumption that they are indeed due to rotation. They make a point that in order to support such a rapid rotation, this pulsar must be more massive than usual, resulting perhaps from fall-back of significant amount of debris from the supernova on to the newly born neutron star.

If one admits that the 0.5-millisecond pulsation is due to rotation then this pulsar has sprung another surprise! Most neutron stars, young and old, have a magnetic field of about 10^{12} gauss (compared with ~ 1 gauss for the Earth). Bhattacharya and Srinivasan argue that the magnetic field of this pulsar cannot be much more than 10^{9} gauss. Such a low magnetic field for a young pulsar is contrary to conventional wisdom, and their paper explores the various implications in this regard.

Both these alternative models have very clear predictions, and future observations will clarify things considerably. But alas, the veil has closed again on the pulsar. Various observations done in Chile and Australia subsequent to the initial discovery have not been able to detect the pulsar. This has led to some uneasiness. But perhaps there is nothing to worry. There is still a lot of debris of the explosion surrounding the central pulsar. It may simply be that one was fortunate enough to look through a hole in the ejecta. If so, as the debris continues to expand and thin out, the pulsar should be recovered again. Meanwhile all telescopes in the southern hemisphere are pointed towards this supernova.

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