news and views

Another optical pulsar

from Jocelyn Bell Burnell

EVER since the discovery of optical flashes from the pulsar in the Crab Nebula and the association of pulsation in this band with rapid pulsation period, astronomers have expected that the Vela pulsar, the third fastest, should likewise emit pulses of light. But in the 8 years since that initial discovery hope has gradually faded as larger and larger telescopes have searched for fainter and fainter flashes. So far had faith dimmed that consideration was recently given to the unpulsed optical emission of the pulsar, and an attempt made to pick out the candidate star on the basis of predicted magnitude and colour (Lasker *Astrophys. J.* **203**, 193; 1976).

But at last, optical pulsations have been found. In this issue of *Nature* (page 692) Wallace and eleven others (in a paper with more authors than paragraphs) report the detection of optical pulsations from the Vela pulsar. In a collaborative effort between optical astronomers from the Royal Greenwich Observatory and the Anglo–Australian Telescope, and radio astronomers in Australia, faint optical pulses at the same pulsation period as the radio pulses have been recorded. With a time-averaged magnitude of 25.2 this is the faintest thing ever seen (and in good agreement with Pacini's prediction that it would have magnitude about 25 (*Astrophys. J.* **163**, L17; 1971)).

The Vela pulsar has been a particularly troublesome pulsar to deal with. Not only are the light pulsations weak, requiring a large modern telescope such as the AAT with sophisticated equipment for analysis, but the pulsation period of the pulsar itself, as observed by the radio astronomers, is not stable. Pulsars are believed to be rotating neutron stars—stars of a few kilometres radius with a density comparable to that found in the atomic nucleus. The pulsation period is the rotation period, which in the case of the Vela pulsar is 80 ms. The period gradually lengthens as the star loses rotational energy, and, again for the Vela pulsar, this is about 11 ns per day. This is typical pulsar behaviour, although for both the Crab and Vela pulsars the rotation rates are much faster than average and the slowing more noticeable. What is peculiar to the Vela pulsar and partly responsible for the delay in the discovery of the light flashes is the occasional large hiccough or "glitch" of the pulsar, when its rotation rate suddenly increases (typically by 200 ns). The position of a radio pulsar is obtained by the radio astronomers from a study of the Doppler shifts in its pulsation period due to the annual motion of the Earth about the Sun. Erratic behaviour of the pulsar period upsets the determination and uncertainties in the position of this pulsar have not helped the optical astronomers.

The region around the Vela pulsar, PSR 0833-45, is complex. There are many faint stars, and the remains of a supernova—a star that exploded cataclysmically blowing off a shell of material. The pulsar, which may have been formed by the supernova explosion, lies within part of this shell—the part called Vela X by radio astronomers. To add confusion to complexity there are two X-ray sources in the constellation of Vela, Vela X-1 (3U0900-40) and Vela XR-1 (3U0833-45). Vela X-1 shows strong X-ray pulsations whereas Vela XR-1 which is presumably associated with the pulsar does not!

According to Pacini's predictions the pulsated X-ray emission from 0833-45 should be below the threshold of present X-ray telescopes, but γ-ray astronomers have had noticeable success in detecting this pulsar. (The division between X and γ-ray astronomy is made on the basis of photon energy, the divide being around a few hundred keV, and is independent of the method of production of the photons.) So successful have been the γ-ray astronomers (with the COS B satellite, for example), that one wonders whether it might not be reasonably strong in X rays too. It will be interesting to learn more about the X-ray source: where it is in relation to the pulsar, what it is, and what fraction of the X-ray emission is pulsed.

It is tempting to assume that the Vela pulsar is similar to the Crab only less energetic: both are rapid pulsars, both emit pulses at the radio pulse period over a wide range of the electromagnetic spectrum and at γ-ray energies their pulse profiles are strikingly similar. But there are striking differences too, notably that whereas for the Crab the radio, optical, X- and γ-ray pulses are all in phase, in the Vela pulsar the radio pulse apparently precedes the optical and γ-ray pulse.

One is reluctant to divide a sample of two into two separate categories, and, unfortunately, there are unlikely to be many more samples on which to establish such a division. This makes this discovery and the consequent observations all the more important. □

Correction

Changes in proof to the article by Roberts and Falkow in last week's *Nature* (**266**, 630; 1977) require the following correction to be made to the accompanying comment in *News and Views* (**266**, 586; 1977). In paragraph 3 it is stated that the 25 Mdal sex-factor plasmid has not yet been found to be transferred to recipient strains along with the drug resistance plasmid. Roberts and Falkow have now found that it is transferred to recipient strains of *Neisseria gonorrhoeae*.