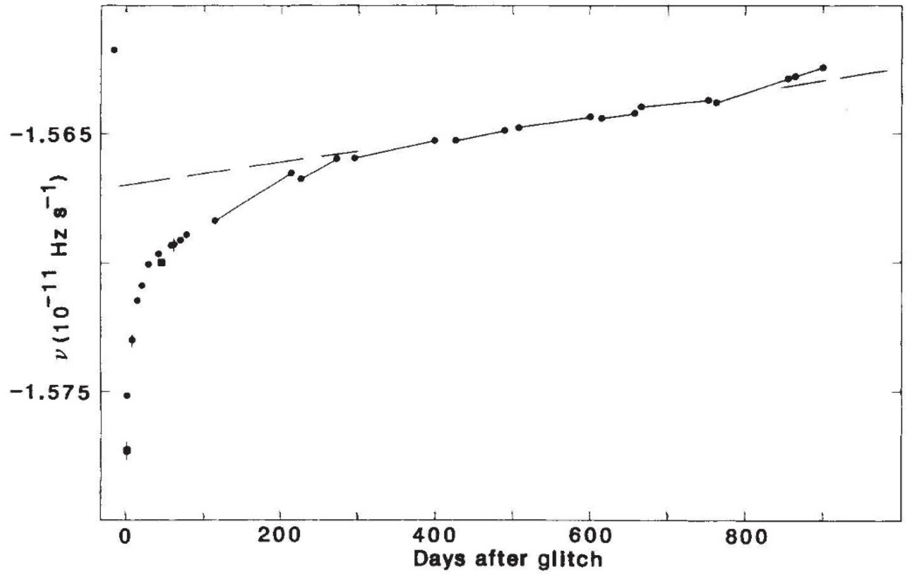

Recovery of pulsar spin-down (for PSR0833−45) after a glitch. The pre-jump frequency derivative is given by the point in the top-left corner and the two phases of recovery can be seen (from ref. 8).

1975 glitch[10], not all of the period derivative increment decayed away, so that after about 50 days the pulsar was rotating *less* rapidly than it would have been had the glitch not occurred. Although the data spans are much shorter, no glitches at all have been observed in the two other known pulsars (PSR0540−69 and PSR1509−58) which are younger than the Vela pulsar.

Following the first Vela glitch, Baym *et al.*[11] suggested a model in which the glitch was due to a sudden cracking of the solid crust of the neutron star — a starquake — with a resulting reduction in the moment of inertia and hence spin-up of the pulsar. The suggestion that the interior of a neutron star is superfluid (made well before the discovery of pulsars[12]) and hence only weakly coupled to the crust, provided a neat explanation for the long timescales of the post-glitch recovery. This model was very successful in that it accounted for the increase in period derivative at the time of the glitch and its gradual decay. However, it could not cope with the recurrence of large Vela glitches every few years.

The model that currently seems best able to explain these large and frequent glitches involves pinning and unpinning of the normal-fluid cores of vortices in the neutron superfluid from crustal nuclei. A sudden unpinning of a small fraction of the cores and the consequent transfer of angular momentum to the crust accounts for the glitch and a gradual return of the creep rate of these cores to the equilibrium value accounts for the slow relaxation. By invoking two different regions of unpinning with different relaxation times, this model can account for the broad characteristics of the Vela glitches and the short and long recovery timescales following the glitch[13]. The different glitch characteristics of the very young pulsars may result from higher temperatures in their interior allowing a smoother transfer of angular momentum from the superfluid core to the crust.

Although the vortex-creep model gives a satisfactory fit to much of the observational data, there is much that is difficult to explain. For example, the difference in the post-glitch behaviour of different pulsars does not have a natural explanation in terms of the model. In the case of the Crab, the persistent change in period derivative seems to imply a change in the processes of rotational energy loss from the star. It may be that some entirely different mechanism is responsible for the glitches in very young pulsars. In any case it is clear that careful study of the frequent glitches observed by McKenna and Lyne in PSR1737−30 will put new constraints on glitch models and lead to a greater understanding of the processes occurring in the superfluid interior of neutron stars. □

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DAEDALUS

Heavenly visions

LAST week Daedalus devised a process for making metallic snow, by cooling a metal vapour diluted with inert gas. The more dilute the vapour, the smaller the resulting solid particles. At a high enough dilution, a fine metallic 'smoke' results. Each particle is a single unbranched needle-crystal of metal, less than a micrometre long.

Daedalus sees his metal-needle smoke as the optical equivalent of the airborne strips of metal foil used to confuse military radar. Each strip is cut to a quarter wavelength of the radar transmission, and resonantly re-radiates it as an enormously enhanced echo. Similarly, a suspension of Daedalus's micro-fine metallic smoke will selectively scatter light for which its needles are quarter-wave resonators. Other wavelengths of light will be quite unaffected.

Released into the atmosphere, the new smoke would have intriguing effects. In cloudy weather, a release of blue-scattering smoke would selectively transmit yellow light, cheering and brightening the day. The blue light thus scattered would tinge the visible scene, 'expanding' the landscape with a false impression of great distance. In cloudless conditions, an ultraviolet-scattering smoke could guard sunbathers from sunburn, while an infrared scattering one could shield them from heat stroke.

But Daedalus despises such free, universal, compulsory socialist benefits. He wants his metallic smoke to make money. So DREADCO's physicists are releasing into the atmosphere thin, almost invisible suspensions of a blue-scattering smoke, and then 'writing' on them with a distant polarized infrared laser. Where it hits the smoke plume, the infrared beam aligns the needle crystals along its polarization axis. These regions of alignment become polarizers themselves. So they preferentially scatter the blue light of a cloudless sky, which is itself polarized, and show up as dark writing against the celestial blue. The image fades almost instantly as the aligned particles lose their orientation by random brownian decay. To maintain a still or moving picture, Daedalus will have to project a continuously scanning video-modulated infrared 'raster' on the invisible smoke plume, like the electron beam of a television receiver.

When perfected, DREADCO's polarized-laser sky-writing system will turn the whole wide blue sky into a TV screen! Advertisers should pay copiously to write slogans, images, or even complete commercials on the heavens. Holiday resorts would love to woo the electronic generation with the idyllic double pleasure of lazing on a sunny beach while watching endless TV-in-the-sky. Only the sound track, relayed from municipal loudspeakers, would remain earthbound.

David Jones