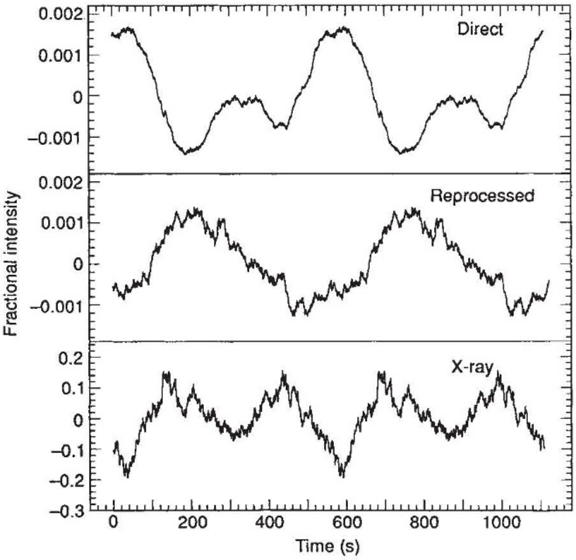

Direct (top), reprocessed (middle) and X-ray pulsations from V471 Tauri, for two cycles, showing phase differences. (From ref. 3.)

radial oscillations of the white dwarf, or to shadowing of the white dwarf's precessing magnetic poles as material is accreted and funnelled onto them along the field lines.

The simplest test to choose between the two models was to compare the phases of the pulsations in X-ray data and optical data. With physical pulsations modulating the star's temperature, the optical and X-ray fluctuations would be in phase. With the magnetic rotator, the pulses would be out of phase: the accreted material would block X-rays at the poles, whose diminished radiation would sweep past us as the star rotates once every 555 seconds, but would make them optically brighter, as the stellar energy must be radiated somehow.

Comparing the Whole Earth Telescope optical data with X-ray observations from the ROSAT satellite[7], Clemens *et al.*[3] come down in favour of the magnetic-rotator model, with the X-rays and optical radiation out of phase (see figure). In addition, they found optical pulses with a period of 562 seconds, attributable to reprocessed radiation from the K2 dwarf as it is periodically illuminated by its rotating white-dwarf companion. The 7-second difference in period is nicely accounted for by the slow orbit of the two stars around one another.

Where does the accreted material come from? Although there is no Roche-lobe overflow from the K2 dwarf, the star is magnetically active, like the Sun, with flares and loop structures[8], and in 1989 we showed that it also drives a stellar wind[9]. The white dwarf's poles could be trapping material from this. It is puzzling that high-resolution far-ultraviolet spectra of V471 Tauri show none of the spectral lines that would be expected if material is being accreted[10]. This will require some explanation. Astrophysicists would also like to know how large an area of the white dwarf is being shadowed, and the strength of the magnetic field funnelling the wind down onto the poles.

The Hubble Space Telescope and the newly launched Extreme Ultraviolet Explorer (EUVE) satellite should help clarify matters. EUVE, in particular, should reveal the tell-tale soft-X-ray signatures of abundant elements such as C, N, O, Si and Fe when the darkened pole faces towards us, if the magnetic rotator model is correct. The degree to which the EUVE spectra change as the white dwarf rotates will tell us something of the geometry (size, latitude) of the accreting region. The inability of the International Ultraviolet Explorer (IUE) to detect metal-line features[10] places tight limits on the accretion rate of accretion of ionized species, and raises the possibility that these are batted away by the star's rotating magnetosphere while neutral helium in the K2 wind is accreted. With sufficient time resolution, EUVE spectra could elucidate this.

The ultimate prospect is of learning from V471 Tauri about the physics of diffusion in the presence of the high gravitational field of a white dwarf, about the magnetism of white dwarfs, about the physics and geometry of magnetically channelled accretion, and about the stellar wind (especially its variability) from K2 dwarfs. And if the binary truly is a strongly magnetic, pre-cataclysmic binary, then it would be the first to be identified as the immediate precursor to the well known DQ Herculis class of magnetic nova systems. □

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DAEDALUS

Loaded crystal

Explosive antimony is a chemical curiosity. Made by electrolysis of antimony trichloride, it explodes violently under heat or impact, giving ordinary metallic antimony. Since a pure element cannot undergo any chemical change, Daedalus reckons that the explosion is simply an energetic change of crystal habit. He reasons that all substances, elements and compounds alike, should have such explosive crystal forms. After all, their atoms or molecules can be packed together in innumerable different ways. Some will have vastly higher energy than the normal form, but will be held in being by some energy barrier or the absence of a feasible transformation mechanism. No phase diagram will show them, but they must be there. How can they be made?

Daedalus plans to harness the crystal-modifying powers of proteins. There is a bacterial protein that nucleates the freezing of water, and a converse anti-freeze protein that stops ice crystals growing inside arctic fish. The wonderfully elaborate silica skeletons of radiolaria, and the complex shells of molluscs, are all created from simple minerals by protein-controlled crystallization.

So DREADCO's chemists are looking for such proteins. Modern bead-supported synthesis makes it easy to produce all sorts of crazy proteins to order, and the chemists are tipping them into solutions of salt, soda, and so on, to see what happens. Either by increased understanding, or by sheer blind exploration, they hope to produce ordinary substances in amazing new crystal forms, packed with enough energy to be explosive, yet stable enough to be handled safely.

The feebler varieties will come in handy for packaging. The self-opening can with an exploding metal seam, the self-destroying 'plastic explosive' bag or wrapping and the self-shattering bottle should all be widely welcomed. The apostles of planned obsolescence will rush to incorporate such materials into cars, refrigerators, hi-fi equipment, and so on. The no longer proud owner could simply light the blue touch-paper and watch the redundant item burst violently to dust and fragments. With no combustion or chemical reaction to generate flame, smoke or fumes, it could be safely set off indoors.

The more powerful explosives, perhaps energetic forms of salt or sugar, will be equally fume free. They will transform mining and tunnelling. Daedalus even has hopes of finding a high-energy ice with a melting point comfortably above room temperature. Exploding directly to steam, it would be an ideal non-polluting fuel for road transport.

David Jones