The isolation–compaction mechanism suggested in this issue is one of several plausible mechanisms. Pore pressures might also be elevated by fluid flow upwards from a deep source[4] or by a fluid pressure gradient normal to the fault owing to the properties of the surfaces of fine-grained minerals in the fault zone[6]. But once seals have formed by any mechanism, the strength of the rocks becomes coupled to the state of the pore fluids in ways that produce exceptionally complicated behaviour. For example, diffusive surges of fluid might develop and propagate upwards from a deep, overpressured source of water, if the slipping fault has high permeability along strike, but low-permeability walls, and if permeability depends strongly on effective normal stress[5].

Even withstanding incoming fluids, fault strength and stability might be influenced by several competing effects, each of which has a different characteristic timescale. Stress corrosion cracking in the surrounding rocks, pore fluid diffusion or dilatancy hardening along the fault zone may delay sliding instability to larger slip distances than predicted for the same fault system over a very long time[7]. Pressure-solution deformation might reduce long-term strength[8], whereas the isolation–compaction mechanism described by Blanpied *et al.* would reduce short-term stability of sliding. But, in competition with the latter two effects, cementation, sealing and lithification could harden the fault rocks, causing the fault to strengthen, reducing permeability of the surrounding rocks, and increasing elastic stiffness of the surrounding rock[9,10]. Along natural faults with complicated geometry and mineralogy, it is of course possible that all of these various processes occur in combination.

To predict the response of rocks to tectonic loading, it is necessary to understand something of the kinetic rates of each physical mechanism of fault weakening and strengthening. Compaction of the fault rocks, for example, could occur either by fracturing[11] or solution-transfer processes, at rates which would depend on temperature, loading conditions, pore-fluid chemistry, mineralogy and porosity. Rates of crack healing and associated permeability reduction in the country rock will depend on the geometry and shapes of the cracks[12], as well as on environmental parameters.

When these processes are taken in combination, a rich variety of mechanical behaviour is possible and, unfortunately, few firm experimental and geophysical constraints are available. Blanpied *et al.* have made an exciting contribution, but there is still plenty for the rest of us to look at. ☐

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ASTRONOMY

Puzzling pulsations explained

Edward M. Sion

COMPRISING a pair of dwarf stars (one a white dwarf) that orbit one another almost twice a day, V471 Tauri has fascinated astronomers since it was discovered[1] in 1970. In 1986, mysterious pulsations with a period just over 9 minutes were found[2] in the binary's X-ray output, which must originate at the white dwarf — but how could not be determined. Now, using the Whole Earth Telescope (see box), Clemens *et al.*[3] show that in between the X-ray pulses, the binary becomes optically bright. This evidence is just what astrophysicists needed to understand what is going on.

V471 Tauri is just about a made-to-measure astrophysical laboratory, where astronomers can study the physics of degenerate matter, the nature of stellar magnetic activity, and the origin of explosive close binary pairs. The two stars in the system are a hydrogen-rich white dwarf and a main-sequence K2 dwarf. The former is a collapsed star at the end of its life and is made of degenerate matter; the latter is a highly active, mass-losing star with a magnetic dynamo not unlike the Sun's. Because the two stars eclipse one another during their 12½-hour orbit, and because the pair is in the Hyades star cluster, their age, original mass and present physical parameters are all well constrained.

THE Whole Earth Telescope (WET) is a global network of telescopes consisting of many observatories at longitudes spaced around the planet, thus allowing nearly unbroken, around-the-clock monitoring of a star's brightness. The brainchild of R.E. Nather at the University of Texas, Austin, WET is, in a sense, a single multi-mirror telescope because it is operated that way, resulting in data ten times more continuous than are obtainable from a single observatory site. To uncover and resolve all of a pulsating star's oscillation periods (most are multi-periodic) and to use their frequency spacings and amplitudes to probe the star's interior (astroseismology), the WET coverage is absolutely essential. Applied to white dwarf stars, WET has already yielded interior compositions, atmospheric layer thicknesses, rates of thermal cooling, masses, rotation rates and other fundamental physical parameters. **E.M.S.**

A compelling reason for interest in the binary is that it has evidently evolved from the poorly understood 'common envelope' state: the more massive in the pair (now the white dwarf) had expanded to a red supergiant at the end of its main-sequence phase, engulfing its partner in a common envelope of gas; frictional drag then caused the two to spiral towards one another, giving the present close separation.

Also, the binary pair is on the verge of becoming a cataclysmic variable. With a little more shrinkage in the orbit, the atmosphere of the K2 dwarf will spill over onto the white dwarf (Roche-lobe overflow). At this point, the white dwarf's surface will accrete the excess material, fuelling the sporadic runaway thermonuclear reactions we see as classical novae. With the timescale for such a change over being astronomically small[4] (less than a billion years), we have the prospect in V471 Tauri of viewing part of the evolution of a cataclysmic variable.

Lastly, an expanding shell of cool gas around the binary[5] may indicate the past occurrence of a nova explosion; perhaps the white dwarf captured material from the K2 dwarf, even without Roche-lobe overflow. Chinese records of a "guest star" (nova) in the vicinity[6] in 396 AD may be related to this.

But the crowning glory of V471 Tauri for astrophysicists was the discovery of the unprecedented 555-second pulsations in the X-ray flux[2], and later in optical data[7]. The eventual consensus was that the pulsations are due either to non-