A pulsar's beat goes on, but slower

Every 2 minutes or so, the X-ray signal from a stellar source known as GX1+4 dims and then brightens. During the 1970s, the rate of those pulsations was slowly increasing. Around 1980, the source unexpectedly became so faint even sensitive satellite instruments couldn't detect it. Now the Japanese satellite Ginga has observed a newly strengthened X-ray signal coming from GX1+4. This time, the pulsations appear to be gradually slowing — an unusual shift that astronomers find difficult to explain.

GX1+4 is an X-ray pulsar — a dense, compact, rapidly spinning neutron star that draws gaseous material from a nearby companion star. The captured material forms into a disk or ring, and the neutron star's intense magnetic field funnels some of the gas into the star's polar regions, where the falling gas generates X-rays. As the star spins, X-ray beams from these regions sweep the sky like lighthouse beacons to produce the characteristic pulsed signal seen from earth. By observing the pulses, astronomers can determine the star's spin rate.

Matter falling onto a star can alter its rotation period. As the material spirals in from a ring rotating in the same direction as the star, it adds its spin to the star's spin, and the star's rotation rate increases. How such a process slows a star's spin is not as well understood.

One possibility is that the neutron star's magnetic field is so strong it actually disrupts the surrounding ring of material. That interaction increases the drag on the star, even when the ring is rotating in the same direction as the star. Another possibility is that the stellar wind streaming from the companion star to the neutron star changes direction, forcing material to spin down to the neutron star in opposite directions at different times.

However, the spin behavior of GX1+4 fits neither model well. K. Makishima of the University of Tokyo and his colleagues, who report the Ginga results in the June 23 NATURE, argue that the ring orbiting the neutron star has probably reversed its direction, and the incoming matter is slowing the star's spin. But unlike other X-ray pulsars, GX1+4 has a red giant star as a partner, and a red giant produces a slow, weak stellar wind unlikely to alter the ring's motion.

Theoretical calculations indicate that magnetic braking may be equally implausible. This mechanism would require a magnetic field significantly larger than any yet observed for a neutron star. The lack of a good explanation leaves astronomers puzzled, but excited by the chance to study in detail how a star spins down.

— I. Peterson

Dilutions or delusions?

"An experiment whose conclusions have no physical basis is described in this week's [June 30] issue," say the editors of NATURE. With that comment, they feature a paper by 13 researchers testing the hallmark of homeopathic medicine: the use of minute doses of drugs that bring on symptoms similar to the disease to stimulate a cure.

The international team appears to have demonstrated that white blood cells called basophils react to an antibody solution after the equivalent of 120 tenfold dilutions. The antibodies normally bind to and disrupt basophil membranes until the membranes can no longer hold a laboratory stain, a process known as degranulation. Such an infinitesimal concentration, however, should not contain enough antibody molecules to damage the cells. In theory, all the antibody would have been diluted out. But the scientists found 40 to 60 percent of the basophil membranes disrupted by such a weak solution, catching attention from the French press and homeopathy fans worldwide prior to the study's publication.

Six laboratories in France, Italy, Israel and Canada duplicated the elaborate series of blinded experiments, which involved diluting the antibody solution, labeling cells and detecting degranulation after exposure to the solution. At the request of NATURE's editors, the study's primary author, Jacques Benveniste of the University of Paris-Sud, has agreed to repeat the procedure under the watchful eyes of independent investigators.

"It's just important that the work is published," observes Patricia Fortner of the University of Toronto and one of the study's authors, "so we can get feedback from around the world."

The researchers build their hypothesis to explain the startling findings around the molecular behavior of water. The solution had to be vigorously shaken for at least 10 seconds before it would cause degranulation. That means, they say, that "specific information must have been transmitted during the dilution/shaking process. Water could act as a 'template' for the [antibody] molecule, for example, by an infinite hydrogen-bonded network, or electric and magnetic fields."

NATURE Editor John Maddox offers a simpler explanation: "It must be some systematic error." Although the original paper was reviewed for two years before publication, Maddox says the results of Benveniste's second run of the experiment will appear in NATURE later this summer.

— L. Beil

Laser chemistry not a snap — but possible

When lasers were invented, chemists quickly realized it should be easy to use their special properties to precisely snip apart molecules and drive difficult chemical reactions. It should be easy, but it hasn't been. For the last 25 years the problem has stymied chemists, who have succeeded only in using the laser as a high-tech bunsen burner to heat up molecules rather than cleave them neatly.

Now Princeton (N.J.) University chemist Herschel Rabitz has applied engineering design principles to suggest a way to make the process work. "Once and for all we know the right way of looking at the problem, and it is not impossible — which is what people began to start saying," Rabitz says. The first obstacle to overcome was the presumption that the problem *should* be straightforward, he says.

A molecule will absorb specific frequencies of light because the chemical bonds between different atoms in it will be excited by specific parts of the electromagnetic spectrum. Chemists quickly grasped the idea of using a laser to hit the molecule with one frequency of light, exciting one specific chemical bond in the molecule until it broke, leaving it open to react with another molecule but leaving the other bonds untouched. "But that bond isn't isolated from the rest of the molecule," Rabitz says, and other parts of the molecule may bend and vibrate, interfering with the target bond's absorption of the laser's energy.

Rabitz' solution involves using "optimal design theory" to craft a laser pulse to do the job. Rabitz proposes zapping a chemical solution with a short (10^{-15} second) pulse of light, and feeding the molecules' reaction to the light into a computer, which would decide how to change the next pulse to do the job better. The computer might change the wavelength, polarity or length of the laser pulse. Once this system settled on the best pulse design, chemists would drive the actual reaction with just the laser and without the computer's help.

Rabitz and others are now attempting to make his approach work in the laboratory, although it may take years to solve the technical problems. Once the technique is developed it could be a boon to synthetic chemists, who currently take great pains to protect one part of a molecule while changing another part in a chemical reaction. The technique also "opens up the prospect of studying molecules in ways that are not possible now," Rabitz says.

— C. Vaughan