Heavenly chaos: A star's erratic emissions

Erratic. Irregular. Unsteady.

These words aptly describe the variable star R Scuti, which brightens and fades in a random, nonlinear pattern that seems to defy simple analysis. But now elated researchers find that another word also characterizes the luminosity of this aging Milky Way resident: chaos.

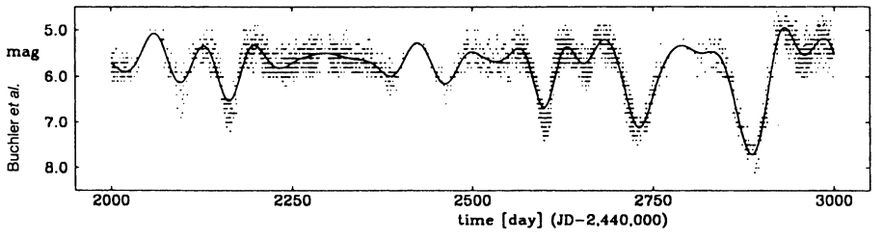
That's chaos in the mathematical sense, which in this case indicates that R Scuti's complex behavior actually obeys a series of routine differential equations. This analysis suggests that relati ely simple physics may account for the star's variable disposition. Previously, researchers have had to invoke an ad hoc mechanism to explain these fluctuations.

"That the irregular pulsations of a complicated system such as a star should have such a simple underlying dynamics is remarkable," note physicist J. Robert Buchler of the University of Florida in Gainesville and his colleagues in the Feb. 6 PHYSICAL REVIEW LETTERS.

"But perhaps the most important potential impact on astronomy is that it may convince observers that useful information can be extracted from the observations of irregular variable stars and that these stars thus deserve more attention than they have been getting," the team adds.

Buchler and two of his collaborators, University of Florida physicists Thierry Serre and Zoltán Kolláth, had long sought to study a star whose variability might fit the nonlinear but mathematically well characterized pattern known as chaos. But for most stars, astronomers hadn't gathered sufficient data for the team to analyze properly the variations in light emissions.

"It's not easy finding a star that has been studied long enough and [often] enough," Buchler says.



Graph shows that the star R Scuti brightens and fades erratically over time.

The researchers settled on R Scuti because of its brightness and the wealth of long-term observations compiled by Janet Mattei, director of the American Association of Variable Star Observers in Cambridge, Mass. The group coordinates observations of a worldwide network of amateur astronomers.

The team's finding that R Scuti's luminosity fits a chaotic pattern provides no guarantee that the variations have a particularly simple explanation, the researchers emphasize. Indeed, in its broadest mathematical sense, chaos imposes one key requirement: that a system with a given set of initial conditions, such as a particular value for its starting position and momentum, will evolve far differently than the same system with a set of initial conditions varying only infinitesimally from the first.

However, the researchers determined that the type of chaos exhibited by R Scuti has an "embedding dimension" of four, meaning that just four variables suffice to describe the star's behavior. This, in turn, suggests that among the star's many modes of vibration — similar to those generated in an organ pipe — the interaction of just two may account for the changes in luminosity.

Buchler explains that when heat flows from the star's hot core to outlying layers of gas, it excites these vibrations. The fluctuations of a similar kind of star, AC Herculis, have the same explanation, he adds. — *R. Cowen*

Brain scans tag sexes as words apart

More often than they would like, men and women have trouble talking to one another. A new study suggests that even when the sexes communicate well, the brains of men and women typically differ in at least one important step in piecing language together.

That divergence takes place in a frontal region of the brain linked to the regulation of speech sounds. This area shows sex-specific responses to a simple task that calls for the comprehension of sounds corresponding to written letters, assert Bennett A. Shaywitz, a neurologist at Yale University School of Medicine, and his colleagues. In men, this linguistic chore boosts brain activity mainly on the left side; in women, both sides of the region respond in roughly equal proportions.

"Our data provide clear evidence for a sex difference in the functional organization of the brain for a specific component of language," Shaywitz's group contends in the Feb. 16 NATURE.

Prior reports that language abilities are handled mainly in a man's left hemisphere but are spread more evenly over both sides of a woman's brain have sparked much controversy. Beginning about 15 years ago, studies suggested that men with damage to the left hemisphere suffered language disorders more often than women with similar damage. Evidence also indicated that men showed larger differences between verbal and nonverbal intelligence after damage to either hemisphere.

However, several investigations of brain-damaged patients failed to confirm these findings.

Shaywitz and his coworkers studied 19 men and 19 women, all of them right-handed, using functional magnetic resonance imaging. This technique enables scientists to measure blood-flow changes in precise areas of the brain.

The researchers first charted blood-flow surges sparked by general visual processing and letter recognition during tests in which volunteers judged whether two sets of letter strings displayed the same pattern of upper- and lowercase letters. They then collected blood-flow data while volunteers decided whether pairs of visually presented nonsense words rhymed.

Mathematical subtraction of the former images from the latter ones yielded a view of brain activity devoted solely to the mental manipulation of speech sounds in the rhyming task, the investigators say. In that exercise, blood flow accelerates in an area known as the inferior frontal gyrus.

For all 19 men, the increase was concentrated in the left hemisphere of the frontal structure. For 11 women, blood flow rose nearly evenly on both sides of the brain; the other 8 displayed a tendency toward more activity on the left side, but less than the men did.

No sex differences in brain activity appeared during tests of letter recognition or word comprehension. On all the tasks, men and women performed equally well.

Many regions of the brain that participate in processing speech sounds may work comparably in men and women, Shaywitz's group notes. But their study, they emphasize, reveals sex differences at one site involved in that ability.

Further studies must examine brain activity during other tasks centered on speech sounds, writes psychologist Michael Rugg of the University of St. Andrews in Fife, Scotland, in an accompanying comment. Researchers also need to search for language problems that may more often afflict women after right-hemisphere damage, he says.

— *B. Bower*