AAAS MEETING

SCIENCE NEWS of the week

Jupiter's Spot of Order in Chaos

For centuries, Jupiter's Great Red Spot has stared enigmatically back at earthbound observers and prompted many theories about its nature and origin. During the last decade, images from the Voyager space probes revealed the spot as an eye of stability in the midst of chaotic fluid flow within one of the wide, colored bands, or zones, that encircle the planet. Now, computer simulations are beginning to provide a better understanding of how and why Jupiter's atmosphere developed one (and only one of this size) spot within one (and only one) zone. These recent calculations show that a disordered, turbulent flow on a rotating body can spontaneously develop partial order in the form of a single, long-lived feature very much like Jupiter's ruddy eye.

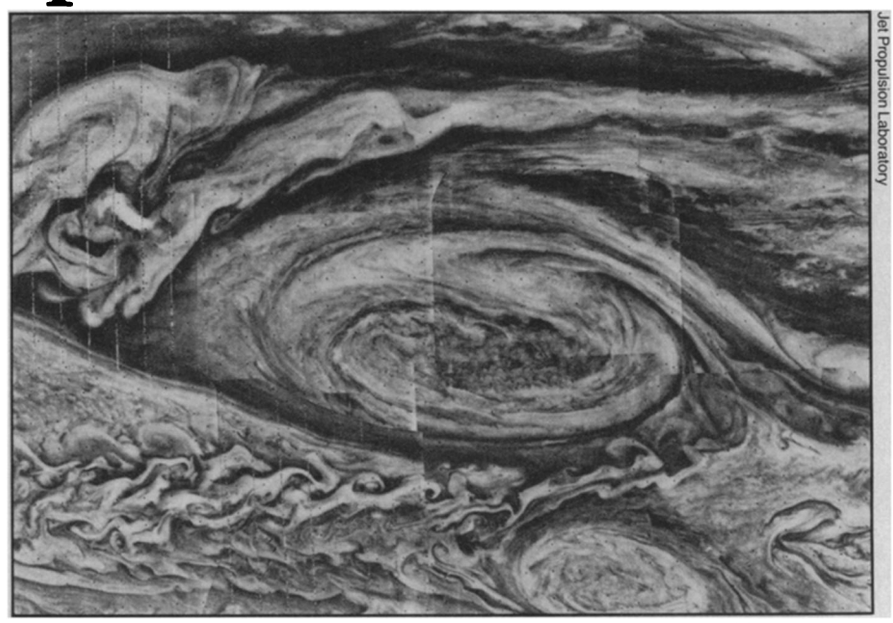
"On Jupiter, one sees flow that is very chaotic, but nonetheless one also sees something well organized," says applied mathematician and astronomer Philip S. Marcus of Harvard University. "One sees the Great Red Spot, which has a lot of order and structure and which has been sitting around at least since Galileo looked at it through his telescope about 350 years ago. And that is a long time compared with other time scales on the planet."

Because of the difficulty in recreating Jupiter's rotating atmosphere in the laboratory and because the amount of data on the planet's dynamics is limited, Marcus has relied on numerical simulations using high-speed computers to do his experiments. "Computer simulation and modeling is a logical way to proceed," he says. Marcus presented his results last week at the annual meeting of the American Association for the Advancement of Science, held in New York.

Using a Cray computer and a simplified set of equations for fluid motion on a rotating surface, Marcus calculated and plotted how various sets of initial flow patterns would change over time within a particular zone. He found that regardless of the atmosphere's initial state, after a sufficiently long time, a zone's atmosphere ends up looking like a chaotic, east-west wind moving generally in a direction opposite to that of the planet's spin. Sometimes a large, stable vortex forms within this chaotic flow.

"What I've done is a numerical simulation that shows if one looks at a wide range of initial conditions, one gets either no spot or just one spot," says Marcus. "That's an empirical, numerically observed fact." The spot itself would have a vortexlike, anticyclonic flow.

Whether a spot shows up seems to depend on the distribution of energy and angular momentum within the planet's atmosphere, says Marcus. Near-equatorial zones like those where the Great Red Spot actually resides are more likely to provide the conditions that promote spot formation. There, variations in the Coriolis force, which are greatest at the equator and smallest at the poles, interact most strongly with the flowing fluid. "It's no surprise, then, to see a spot near the equator," says Marcus, "but you might not see one near the poles."



Jet Propulsion Laboratory

This mosaic, assembled from 12 Voyager 1 pictures, shows the red spot amid chaos.

Marcus also found that if a spot forms, it happens rapidly — within a single Jovian year—yet lasts a long time. If several spots somehow manage to organize themselves for a brief time, they rapidly drift and coalesce into one large spot.

"This simulation doesn't include all of the physics that's on Jupiter," says Marcus. "I'm assuming that whatever is causing the zones to remain where they are has a time scale that is much longer than [the time] it takes those spots to come together." This assumption allows Marcus to consider spot formation independently of zone formation. A zone is necessary as a "garden where red spots can grow," says Marcus. If the zone system were disrupted, the spot would disappear. Saturn has no spot, Marcus says, because the planet's zones of east-west winds have a different velocity profile than those on Jupiter.

"You can't see such things on earth because the zone system of the earth is also broken up by the continents," says Marcus. "As we know from experience, cyclonic and anticyclonic storms and other types of weather on earth last much less than 300 years." However, he speculates that large vortexlike features that have been observed within ocean currents such as the Gulf Stream may be analogous to the Great Red Spot. Such features may be further examples of "order in chaos."

—I. Peterson

AAAS

Drugs throw nutrition roadblock

Certain drugs commonly prescribed to treat psychosis and depression might interfere with vitamin metabolism, leaving even well-fed patients nutritionally deficient, a New York City endocrinologist told an AAAS symposium last week. Preliminary data from his laboratory also raised the possibility that damage to the heart in patients treated with the powerful anticancer drug adriamycin might be linked in part to a similar misstep in vitamin metabolism, says Richard Rivlin of Memorial Sloan-Kettering Cancer Center.

The findings stem from experiments in animals, Rivlin stresses, and are too preliminary to substantiate a change in the current treatment of human patients. Nonetheless, the scientist says he believes the anti-vitamin effect of certain drugs are of "clinical and physiological significance."

"We as Americans are obsessed with the idea that being well nutritionally means eating a good diet," Rivlin says. "But it isn't enough just to eat a good diet. It's important to consider the drugs, hormones and disease that [affect] metabolism as well."

Much of Rivlin's work has centered on vitamin B_2 or riboflavin, a coenzyme that plays key roles in a variety of processes