ATOM & COSMOS

Huge plasma loops drive sun's rotation

Giant structures support theory of heat transport mechanism

BY GABRIEL POPKIN

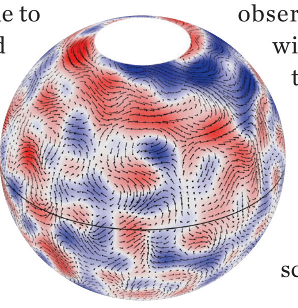
Massive, long-lasting plasma flows 15 times the diameter of Earth move heat from the sun's depths to its surface, according to a study in the Dec. 6 *Science*. The finding supports a decades-old explanation of why the sun rotates fastest at its equator.

In the outermost 30 percent of the sun, known as the convective zone, rising plasma carries heat generated by nuclear fusion in the sun's guts. Once at the surface, much of the plasma's energy radiates into space; the cooler, denser plasma then sinks, driving further convection and creating circulating loops called convection cells. Some especially massive convective structures, called supergranules, can last up to 24 hours and have diameters greater than Earth's.

In 1968, scientists theorized that even longer-lived and larger convection cells, big enough to span the entire convective zone, maintain the fast rotation researchers had long observed around the sun's equator; without such cells, the poles should rotate faster than the equator. Since then, scientists have sought observations of such giant cells.

A team led by David Hathaway of NASA's Marshall Space Flight Center in Huntsville, Ala., looked for these elusive convection cells using the agency's most sophisticated sun watcher, the Solar Dynamics Observatory. The researchers measured shifts in the wavelengths of light radiating from the sun's plasma as it flowed toward or away from Earth, and used the shifts to compute plasma velocities over the solar surface. These velocities revealed the positions of supergranules, a feat Hathaway had already accomplished with data from other observatories.

This time, however, Hathaway and his colleagues were able to use many closely timed observations to see that supergranules traveling across the solar surface were pushed by even larger plasma flows.



The sun's giant convective cells are illustrated (westerly flows in red, easterly flows in blue).

Many of these flows reappeared roughly once every 27 days, the time it takes for a spot on the sun's equator to rotate and reappear in view from Earth. That these flows lasted for multiple rotations strongly suggests that they are the predicted giant convection cells, Hathaway says. His team also found that giant cells appeared to transport fast-rotating plasma toward the equator and slow-rotating plasma toward the poles, confirming other predictions.

The study is the most compelling claim anyone has made about detecting giant convection cells, says Mark Miesch, an astrophysicist at the National Center for Atmospheric Research in Boulder, Colo., who has built computer simulations of solar convection. But, he adds, "I wouldn't call it a slam dunk."

Hathaway acknowledges that the observations don't entirely agree with leading theories. Simulations predict longer-lived cells near the equator and shorter-lived ones near the poles; Hathaway's team found the opposite. Theorists who have read his paper, he says, are "still scratching their heads a bit." ■

GENES & CELLS

To cook up life, just add citrate

Theory that RNA spawned first organisms gets boost

BY SAM LEMONICK

A common biochemical may help forge a missing link in a popular but unproven theory about how life got started.

A leading idea of how loose molecules evolved to become self-replicating cells begins with the hereditary molecule ribonucleic acid. Any RNA-based origin-of-life theory has to include a way for RNA to copy itself. Harvard biologist Jack Szostak and colleagues had previously shown that primitive RNA replication happens best when contained in protocells. These containers have porous walls made of simple fat molecules.

Magnesium ions are also crucial to RNA replication. Without them, the reaction is impractically slow. However, Szostak has found that magnesium ions destroy the walls of his protocells.

In the Nov. 29 *Science*, Szostak and Katarzyna Adamala, also at Harvard, show that citrate, a chemical cousin of the citric acid in lemons and limes, protects protocell walls and allows RNA copying to proceed at a reasonable pace. Citrate latches onto three of the six available attachment points on the magnesium ion, leaving it open enough to assist the RNA reaction but too enclosed to interfere with the protocell walls.

Szostak, though, seems far from declaring victory. "Our goal is finding some reasonable and continuous pathway from small molecules up to more complicated building blocks, then to cells that can start to evolve," he says.

He's already experimenting with alternatives to magnesium and citrate because those substances may not have been readily available on the early Earth. Iron might be able to take the place of magnesium. Instead of citrate, Szostak is thinking of using a protein fragment.

John Sutherland, a chemist at the Medical Research Council in Cambridge, England, thinks Szostak's theory is gathering steam. When a plausible path emerges with many similarities to modern biochemistry, he says, "it's difficult to escape the conclusion that it is actually the way things happened." ■

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