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MAGNETIC PORTALS CONNECT EARTH TO THE SUN

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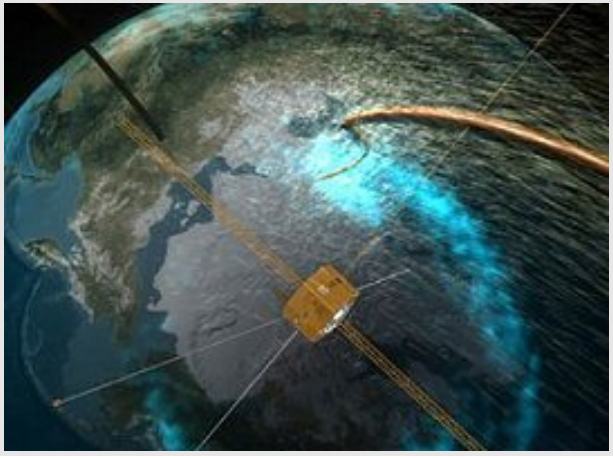
Oct. 30, 2008: During the time it takes you to read this article, something will happen high overhead that until recently many scientists didn't believe in. A magnetic portal will open, linking Earth to the sun 93 million miles away. Tons of high-energy particles may flow through the opening before it closes again, around the time you reach the end of the page.

"It's called a flux transfer event or 'FTE,'" says space physicist David Sibeck of the Goddard Space Flight Center. "Ten years ago I was pretty sure they didn't exist, but now the evidence is incontrovertible."



Indeed, today Sibeck is telling an international assembly of space physicists at the 2008 Plasma Workshop in Huntsville, Alabama, that FTEs are not just common, but possibly twice as common as anyone had ever imagined.

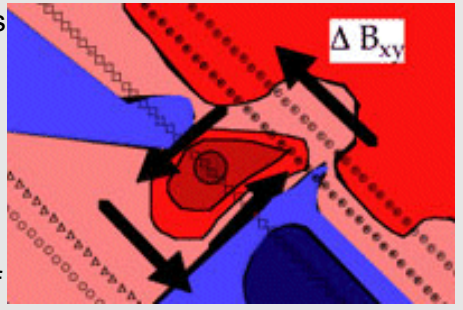
Right: An artist's concept of Earth's magnetic field connecting to the sun's--a.k.a. a "flux transfer event"--with a spacecraft on hand to measure particles and fields. [Larger image]

Researchers have long known that the Earth and sun must be connected. Earth's magnetosphere (the magnetic bubble that surrounds our planet) is filled with particles from the sun that arrive via the solar wind and penetrate the planet's magnetic defenses. They enter by following magnetic field lines that can be traced from *terra firma* all the way back to the sun's atmosphere.

"We used to think the connection was permanent and that solar wind could trickle into the near-Earth environment anytime the wind was active," says Sibeck. "We were wrong. The connections are not steady at all. They are often brief, bursty and very dynamic."

Several speakers at the Workshop have outlined how FTEs form: On the dayside of Earth (the side closest to the sun), Earth's magnetic field presses against the sun's magnetic field. Approximately every eight minutes, the two fields briefly merge or "reconnect," forming a portal through which particles can flow. The portal takes the form of a magnetic cylinder about as wide as Earth. The European Space Agency's fleet of four Cluster spacecraft and NASA's five THEMIS probes have flown through and surrounded these cylinders, measuring their dimensions and sensing the particles that shoot through. "They're real," says Sibeck.

Now that Cluster and THEMIS have directly sampled FTEs, theorists can use those measurements to simulate FTEs in their computers and predict how they might behave. Space physicist Jimmy Raeder of the University of New Hampshire presented one such simulation at the Workshop. He told his colleagues that the cylindrical portals tend to form above Earth's equator and then roll over Earth's winter pole. In December, FTEs roll over the north pole; in July they roll over the south pole.



Right: A "magnetic portal" or FTE mapped in cross-section by NASA's fleet of THEMIS spacecraft. [Larger image]

Sibeck believes this is happening twice as often as previously thought. "I think there are two varieties of FTEs: active and passive." Active FTEs are magnetic cylinders that allow particles to flow through rather easily; they are important conduits of energy for Earth's magnetosphere. Passive FTEs are magnetic cylinders that offer more resistance; their internal structure does not admit such an easy flow of particles and fields. (For experts: Active FTEs form at equatorial latitudes when the IMF tips south; passive FTEs form at higher latitudes when the IMF tips north.) Sibeck has calculated the properties of passive FTEs and he is encouraging his colleagues to hunt for signs of them in data from THEMIS and Cluster. "Passive FTEs may not be very important, but until we know more about them we can't be sure."

There are many unanswered questions: Why do the portals form every 8 minutes? How do magnetic fields inside the cylinder twist and coil? "We're doing some heavy thinking about this at the Workshop," says Sibeck.

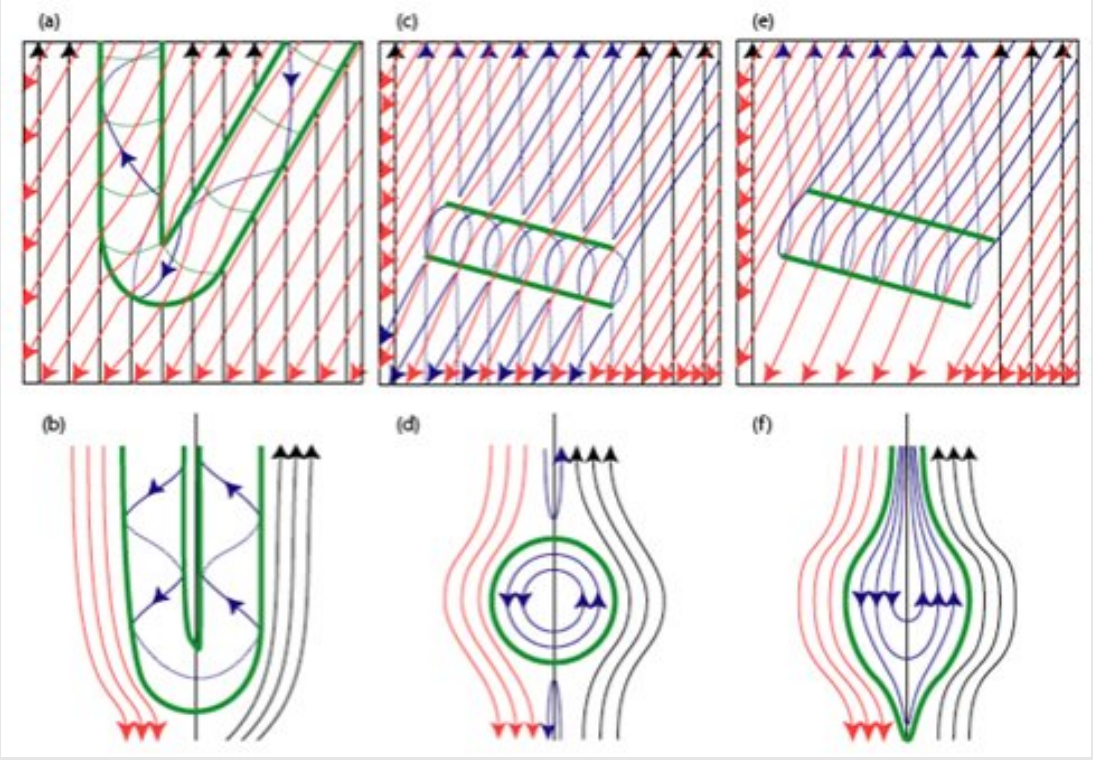
Meanwhile, high above your head, a new portal is opening, connecting your planet to the sun.

Author: Dr. Tony Phillips | Credit: Science@NASA

more information

2008 Huntsville Plasma Workshop → -- home page

Below: In a presentation at the 2008 Plasma Workshop, Robert Fear of the University of Leicester, UK, presented some alternatives for the magnetic topology of FTEs. Possibilities include ropes (left column), cylinders (middle column), or bubbles (right column): abstract.



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Feature

Hidden Portals in Earth's Magnetic Field **07.02.12**

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A NASA-sponsored researcher at the University of Iowa has developed a way for spacecraft to hunt

down hidden magnetic portals in the vicinity of Earth. These gateways link the magnetic field of our planet to that of the sun, setting the stage for stormy space weather. The Magnetospheric Multiscale (MMS) mission will study these portals. Credit: Science@NASA

A favorite theme of science fiction is "the portal"--an extraordinary opening in space or time that connects travelers to distant realms. A good portal is a shortcut, a guide, a door into the unknown. If only they actually existed....

It turns out that they do, sort of, and a NASA-funded researcher at the University of Iowa has figured out how to find them.

"We call them X-points or electron diffusion regions," explains plasma physicist Jack Scudder of the University of Iowa. "They're places where the magnetic field of Earth connects to the magnetic field of the Sun, creating an uninterrupted path leading from our own planet to the sun's atmosphere 93 million miles away."

Observations by NASA's THEMIS spacecraft and Europe's Cluster probes suggest that these magnetic portals open and close dozens of times each day. They're typically located a few tens of thousands of kilometers from Earth where the geomagnetic field meets the onrushing solar wind. Most portals are small and short-lived; others are yawning, vast, and sustained. Tons of energetic particles can flow through the openings, heating Earth's upper atmosphere, sparking geomagnetic storms, and igniting bright polar auroras.

NASA is planning a mission called "MMS," short for Magnetospheric Multiscale Mission, due to launch in 2014, to study the phenomenon. Bristling with energetic particle detectors and magnetic sensors, the four spacecraft of MMS will spread out in Earth's magnetosphere and surround the portals to observe how they work.

Just one problem: Finding them. Magnetic portals are invisible, unstable, and elusive. They open and close without warning "and there are no signposts to guide us in," notes Scudder.

Actually, there are signposts, and Scudder has found them.

Portals form via the process of magnetic reconnection. Mingling lines of magnetic force from the sun and Earth criss-cross and join to create the openings. "X-points" are where the criss-cross takes place. The sudden joining of magnetic fields can propel jets of charged particles from the X-point, creating an "electron diffusion region."

To learn how to pinpoint these events, Scudder looked at data from a space probe that orbited Earth more than 10 years ago.

"In the late 1990s, NASA's Polar spacecraft spent years in Earth's magnetosphere," explains Scudder, "and it encountered many X-points during its mission."

Because Polar carried sensors similar to those of MMS, Scudder decided to see how an X-point looked to Polar. "Using Polar data, we have found five simple combinations of magnetic field and energetic particle measurements that tell us when we've come across an X-point or an electron diffusion region. A single spacecraft, properly instrumented, can make these measurements."

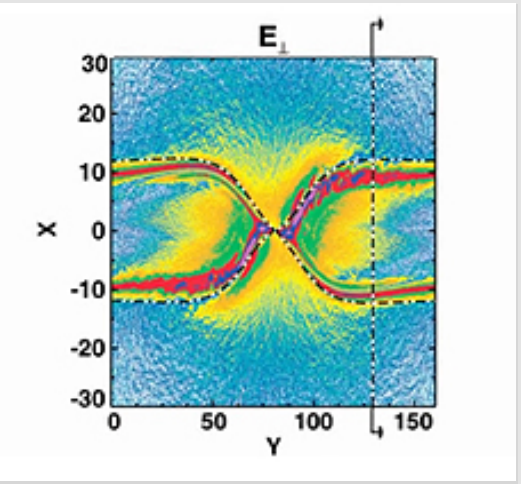
This means that single member of the MMS constellation using the diagnostics can find a portal and alert other members of the constellation. Mission planners long thought that MMS might have to spend a year or so learning to find portals before it could study them. Scudder's work short cuts the process, allowing MMS to get to work without delay.

It's a shortcut worthy of the best portals of fiction, only this time the portals are real. And with the new "signposts" we know how to find them.

Related Links

› MMS Mission site
› NASA THEMIS site
› Polar Mission site
› Magnetic Portals Connect Earth to the Sun

Dr. Tony Phillips
Science at NASA



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Data from NASA's Polar spacecraft, circa 1998, provided crucial clues to finding magnetic X-points. Credit: NASA

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Page Last Updated: July 2, 2012
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