The sun also flips: 11-year solar cycle wimpy, but peaking

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The sun's magnetic field is churning and undulating as it experiences the height of the so-called solar maximum, where the field contorts and eventually flips. Credit: NASA

(Phys.org) —In a 3-meter diameter hollow aluminum sphere, Cary Forest, a UW-Madison physics professor, is stirring and heating plasmas

to 500,000 degrees Fahrenheit to experimentally mimic the magnetic field-inducing cosmic dynamos at the heart of planets, stars and other celestial bodies.

Ninety-three million miles away, the sun's magnetic field—and presumably its dynamo—is churning and undulating as the star experiences the height of the so-called solar maximum, where the sun's magnetic field contorts and eventually flips.

"Solar max," as scientists call it, is an 11-year cycle where the sun's magnetic field reverses polarity, typically spawning sunspots, flares, auroras and geomagnetic storms that, if large enough, can disrupt satellites and fry power grids on Earth.

Over a period of about two years, "the sun's magnetic field switches directions, and we know that because the polarity of the sunspots changes," explains Forest, an expert on cosmic dynamos and the magnetic fields they generate in planets, stars and other objects. "Sunspots are just magnetic fields emerging from the sun. They are the diagnostic feature of what's happening deep inside the sun."

Flowing streams of electrons and protons are what create the magnetic fields deep in the sun's interior. Those surging fields generate sunspots, which can sometimes erupt and release vast amounts of energy in the form of solar flares or hiccups of material known as coronal mass ejections.

Unlike the Earth's magnetic field, which moves up or down as a familiar dipole, the sun's huge magnetic field oscillates and is less evident at the poles of the sun than at its midsection, where sunspots typically occur. "The sun has an AC rather than a DC dynamo," says Forest.

Although solar max usually gives rise to numerous sunspots as well as

big solar flares and storms, the current edition is characterized by tranquil inactivity. There are few sunspots and no massive storms to speak of, says Forest. But the Wisconsin physicist also notes that last year, when solar max was just getting underway, proved to be a great year for auroras, the colorful curtains, bands and streamers of light observed near the poles of the Earth caused by the charged particles from the solar wind colliding with atoms high in the atmosphere.

"You can think about the aurora as a crown, centered on magnetic north or south," Forest says noting that the charged particles are tugged into the atmosphere by Earth's magnetic field, creating the beautiful red, green and yellow displays of light. "Last year's display was really good."

Although this cycle of sun activity is, so far, relatively wimpy, past episodes of the solar maximum have been quite violent and caused serious disruption on Earth. "Every couple of hundred years, there is a major solar flare," Forest says, "and that sends a pulse capable of doing some serious stuff on Earth."

In 1859, a solar superstorm known as the "Carrington Event" after the British astronomer who was the first to observe a massive flare on the sun, created auroras that were so bright that people could read by their light and Rocky Mountain gold miners were stirred from sleep, thinking it was daylight. The event spawned a geomagnetic storm that caused telegraph systems in Europe and North America to fail, throwing sparks from pylons and even giving some telegraph operators shocks. In 1989, a massive geomagnetic storm caused by a coronal mass ejection during solar max, sparked the collapse of the electrical transmission system in Quebec.

"Electrical transmission grids can act like a big receiver that doesn't know how to deal with the energy when it comes in," says Forest, who explains that scientists think very large and potentially dangerous events

occur about every one thousand years or so.

"We see these events on stars all the time," he says. From our sun, he adds, "superflares would likely cause serious problems, disrupting power grids satellites and other system we depend on."

Provided by University of Wisconsin-Madison