

SDO sees new kind of magnetic explosion on sun

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Forced magnetic reconnection, caused by a prominence from the Sun, was seen for the first time in images from NASA's Solar Dynamics Observatory, or SDO. This image shows the Sun on May 3, 2012, with the inset showing a close-up of the reconnection event imaged by SDO's Atmospheric Imaging Assembly instrument, where the signature X-shape is visible. Credit: NASA/SDO/Abhishek Srivastava/IIT(BHU)

NASA's Solar Dynamics Observatory has observed a magnetic explosion the likes of which have never been seen before. In the scorching upper reaches of the Sun's atmosphere, a prominence—a large loop of material

launched by an eruption on the solar surface—started falling back to the surface of the Sun. But before it could make it, the prominence ran into a snarl of magnetic field lines, sparking a magnetic explosion.

Scientists have previously seen the explosive snap and realignment of tangled [magnetic field lines](#) on the Sun—a process known as [magnetic reconnection](#)—but never one that had been triggered by a nearby eruption. The observation, which confirms a decade-old theory, may help scientists understand a key mystery about the Sun's atmosphere, better predict space weather, and may also lead to breakthroughs in the controlled fusion and lab [plasma](#) experiments.

"This was the first observation of an external driver of magnetic [reconnection](#)," said Abhishek Srivastava, solar scientist at Indian Institute of Technology (BHU), in Varanasi, India. "This could be very useful for understanding other systems. For example, Earth's and planetary magnetospheres, other magnetized plasma sources, including experiments at laboratory scales where plasma is highly diffusive and very hard to control."

Previously a type of magnetic reconnection known as spontaneous reconnection has been seen, both on the Sun and around Earth. But this new explosion-driven type—called forced reconnection—had never been seen directly, though it was first theorized 15 years ago. The new observations [have just been published](#) in the *Astrophysical Journal*.

The previously-observed spontaneous reconnection requires a region with just the right conditions—such as having a thin sheet of ionized gas, or plasma, that only weakly conducts electric current—in order to occur. The new type, forced reconnection, can happen in a wider range of places, such as in plasma that has even lower resistance to conducting an electric current. However, it can only occur if there is some type of eruption to trigger it. The eruption squeezes the plasma and magnetic

fields, causing them to reconnect.

While the Sun's jumble of magnetic field lines are invisible, they nonetheless affect the material around them—a soup of ultra-hot charged particles known as plasma. The scientists were able to study this plasma using observations from NASA's Solar Dynamics Observatory, or SDO, looking specifically at a wavelength of light showing particles heated 1-2 million kelvins (1.8-3.6 million F).

The observations allowed them to directly see the forced reconnection event for the first time in the [solar corona](#)—the Sun's uppermost atmospheric layer. In a series of images taken over an hour, a prominence in the corona could be seen falling back into the photosphere. En route, the prominence ran into a snarl of magnetic field lines, causing them to reconnect in a distinct X shape.

Spontaneous reconnection offers one explanation for how hot the solar atmosphere is—mysteriously, the corona is millions of degrees hotter than lower atmospheric layers, a conundrum that has led solar scientists for decades to search for what mechanism is driving that heat. The scientists looked at multiple ultraviolet wavelengths to calculate the temperature of the plasma during and following the reconnection event. The data showed that the prominence, which was fairly cool relative to the blistering corona, gained heat after the event. This suggests forced reconnection might be one way the corona is heated locally. Spontaneous reconnection also can heat plasma, but forced reconnection seems to be a much more effective heater—raising the temperature of the plasma quicker, higher, and in a more controlled manner.

While a prominence was the driver behind this reconnection event, other solar eruptions like flares and coronal mass ejections, could also cause forced reconnection. Since these eruptions drive space weather—the bursts of solar radiation that can damage satellites around

Earth—understanding forced reconnection can help modelers better predict when disruptive high-energy charged particles might come speeding at Earth.

Understanding how magnetic reconnection can be forced in a controlled way may also help plasma physicists reproduce reconnection in the lab. This is ultimately useful in the field of laboratory plasma to control and stabilize them.

The scientists are continuing to look for more forced reconnection events. With more observations they can begin to understand the mechanics behind the reconnection and often it might happen.

"Our thought is that forced reconnection is everywhere," Srivastava said. "But we have to continue to observe it, to quantify it, if we want prove that."

Provided by NASA's Goddard Space Flight Center

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