

## What heats the sun's outer atmosphere?

At several million kelvins, the Sun's outer atmosphere, called the corona, is a thousand times hotter than the underlying solar surface. Understanding what heats the corona to its extreme temperatures is one of the cornerstone questions in space science. New evidence has revealed that coronal heating takes the form of impulsive energy bursts called nanoflares. Although puny by solar standards, each one is the equivalent of a 50-megaton hydrogen bomb, the largest ever detonated on Earth. Millions of nanoflares occur every second across the Sun, and together they pack a real wallop.

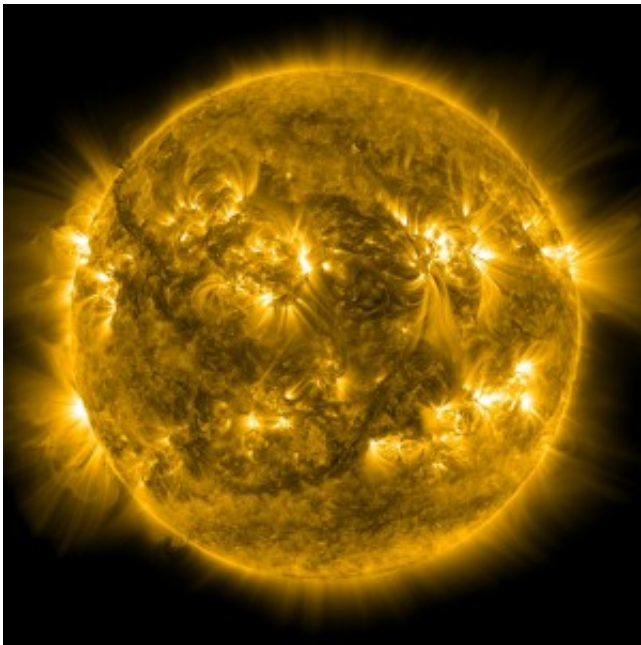


Fig. 1. Extreme Ultraviolet image of the Sun's corona taken by the Solar Dynamics Observatory, revealing plasma (ionized gas) with a temperature of approximately 1 million degrees Kelvin.

Nanoflares have been difficult to study because we are unable to observe individual occurrences. Even with the resolution of our most powerful telescopes, we are stuck seeing multiple overlapping events along the line of sight. As a consequence, progress has had to rely on a combination of observations and theoretical modeling. By comparing what we see with what we expect to see based on computer simulations, we can infer the properties of the energy release. Recently, we have detected faint emission from super-hot plasma (highly ionized gas). This can only be produced by nanoflares, and we consider it to be the “smoking gun.”

So, what is a nanoflare? That's still an open question, but the most likely explanation is that it represents the sudden breaking of stressed magnetic fields that extend upward from the solar

surface and permeate the corona. Turbulent motions at the surface cause the coronal fields to become tangled and twisted much like rubber bands. Eventually, the fields break and release bursts of energy — nanoflares — in a process called magnetic reconnection. It is at the heart of many different phenomena occurring throughout the solar system and the universe. By studying nanoflares, we hope to learn more about these other phenomena as well.

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## **Publication**

[Key aspects of coronal heating.](#)

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