Indian researchers point to Sun's magnetic dance

Why corona is too hot to handle

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New Delhi: Nearly two years ago, a region of the Sun erupted, hurling giant blobs of hot plasma into space, the event's signatures picked up by Aditya-L1, an Indian space observatory positioned about 1.5 million km from Earth.

Now, scientists have used those observations to extract new evidence that the ceaseless dance of magnetic fields in the Sun's atmosphere may hold the key to explaining one of the Sun's oldest mysteries: its extraordinarily hot outer atmosphere.

The study by a team of researchers at the Indian Institute of Astrophysics (IIA), Bengaluru, has addressed a long-standing solar puzzle: why the Sun's corona, or outer atmosphere, is typically about a million degrees hot and can reach tens of millions of degrees during powerful eruptions, while the Sun's visible surface is only about 6,000 degrees.

Over the past several decades, scientists have proposed two mechanisms that could heat the corona, including waves that carry energy and deposit heat into the corona, and the explosive release of energy as magnetic fields snap, reconnect and rearrange themselves.

Now, R. Ramesh and his colleagues at the IIA have found that the waves — ripples that travel through the Sun's magnetic environment — account for only 7 per cent of the energy in the regions where the eruptions occur in the solar atmosphere.

Their findings, published in *The Astrophysical Journal*, suggest that the Sun's reconfiguring magnetic fields account for the bulk of the energy transfer — adding new evidence to explain both the excessive coronal heating as well as rapid replenishment of the lost energy.

"Physicists have for decades used mathematics and computers to model how the Sun's magnetic fields store and release energy," Ramesh told **The Telegraph**. "What was missing was direct observational evidence of how the energy is actually transferred during such eruptions."

The IIA scientists analysed signatures of a coronal mass ejection (CME), the sudden expulsion of blobs of plasma from the solar surface. A CME may occur once or twice a day during the Sun's "quiet" phase, but 10 more CMEs may occur per day during periods of peak solar activity.

The crucial observations came from an instrument aboard Aditya-L1, which can capture images and analyse light from the corona in detail, allowing researchers to infer changes in the plasma's motion and physical conditions during a CME.

India's space agency launched Aditya-L1, a dedicated space-based solar observatory, in 2023.

"This work shows the unique capability of continuous observations with the Aditya-L1 instrument," Dibyendu Nandi, a solar physicist at the Raman Research Institute, Bengaluru, who was not associated with the IIA study, told this newspaper. But, he said, the results for now come from a single CME observation in August 2024.

"Establishing whether the results hold over a statistically significant number of events would be an important future step," Nandi said. The IIA team now plans to perform similar analyses on more CMEs.

The mystery of the hot corona has its roots in a green spectral line detected by two American astronomers while they observed a total solar eclipse in 1869. Scientists initially thought the line came from a previously unknown element they called "coronium".

But 70 years later, a Swedish physicist discovered that the line came from superheated iron, stripped of nearly half its electrons, implying that the coronal temperature was more than a million degrees, nearly 150 times hotter than the solar surface.