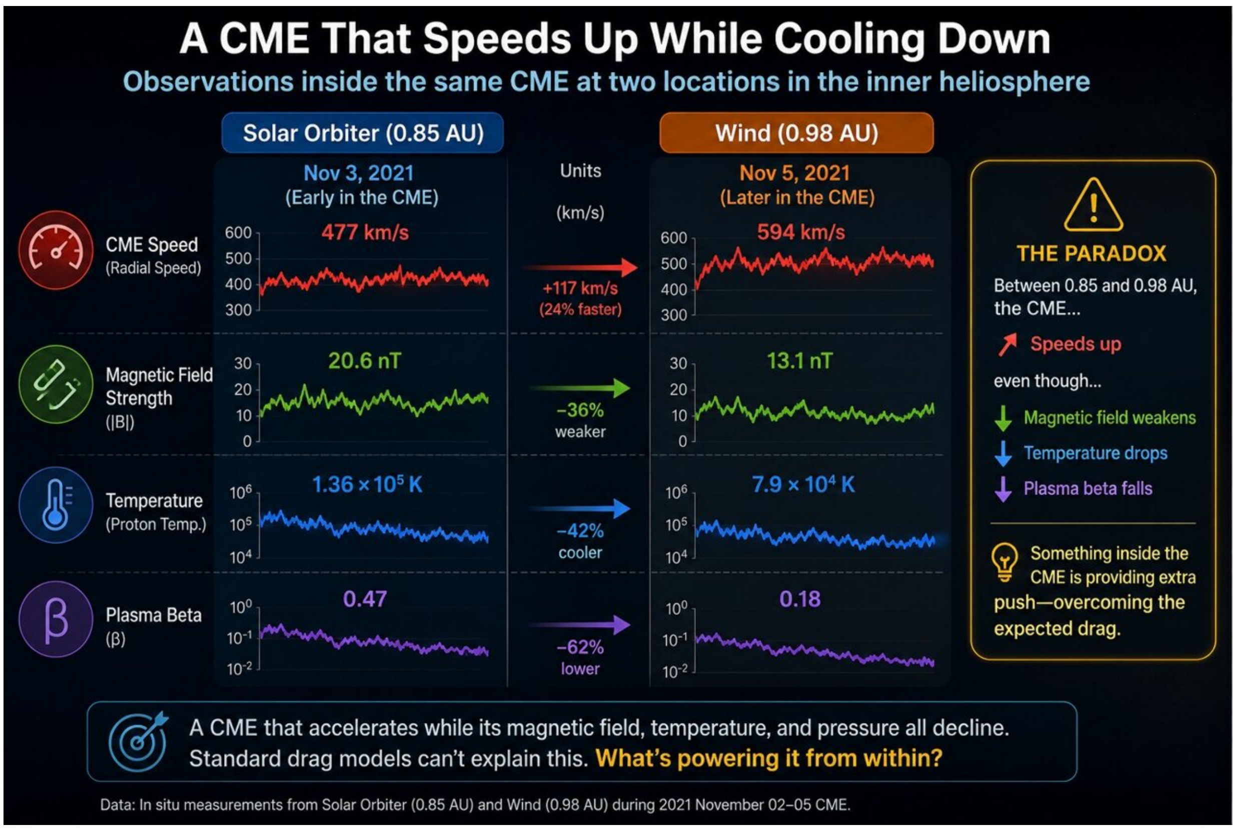
A solar storm was seen speeding up instead of slowing down, and scientists think they know why

June 13 2026, by Sayan Tribedi



Data from Solar Orbiter (0.85 AU) and Wind (0.98 AU) show the November 2021 CME speeding up as it moved away from the sun, despite a weakening magnetic field, lower temperature, and falling plasma beta. This unexpected acceleration challenged standard drag-based models and pointed to an internal energy source within the solar storm itself. Credit: Generated by the author using AI tools for illustrative purposes

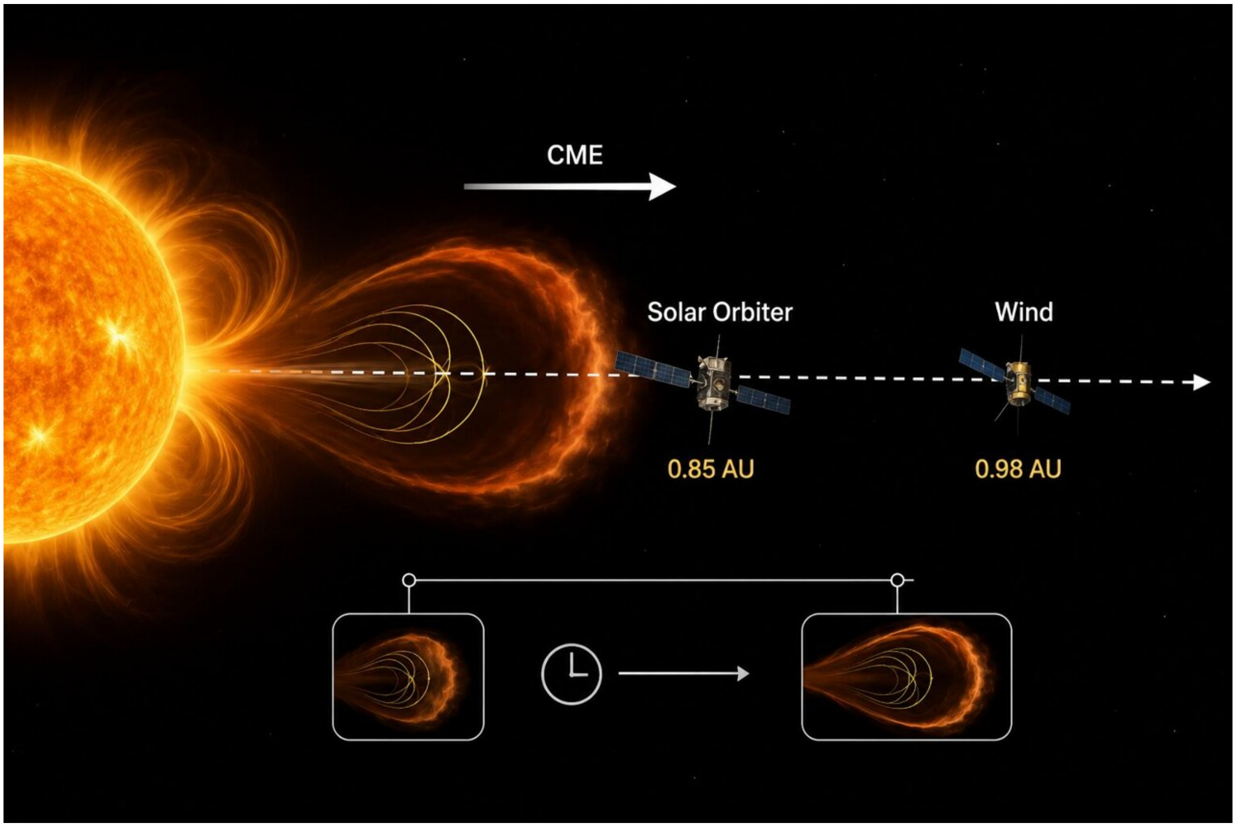
A gigantic solar eruption in November 2021 defied expectations. Two spacecraft—Solar Orbiter at 0.85 AU and Wind at 0.98 AU—watched the same coronal mass ejection (CME) as it zoomed through the solar wind. Normally, a CME plowing into slower wind should slow down, like a boat hitting chop, but this one sped up. It was a genuine space weather mystery. In their paper published in *The Astrophysical Journal Letters*, the researchers report that only an unseen internal "engine" could explain the anomaly.

A solar storm that should have slowed down

CMEs are enormous bubbles of magnetized plasma blasted off the sun. They carry billions of tons of material and corkscrew-shaped magnetic fields, and they are the main drivers of major geomagnetic storms on Earth. Forecasters usually treat a CME like a giant cloud drifting in the solar wind: Slow CMEs accelerate, fast ones decelerate, adjusting to the ambient flow. This "drag-based" model ignores the CME's complex interior, assuming only an aerodynamic push from outside.

So scientists were flummoxed when the 2021 CME did the opposite. It blasted into a slower solar wind, but instead of lagging, it surged ahead. Standard models couldn't reproduce this bulk acceleration. To explain it, one extended model even had to add a mysterious extra force term.

But what was actually pushing the storm? As the authors put it, "This letter disentangles the observed kinematic puzzle by tracing the physical origin of the anomalous acceleration to the multiscale turbulent evolution of the ejecta." The answer lay inside the storm, not in the smooth solar wind outside.

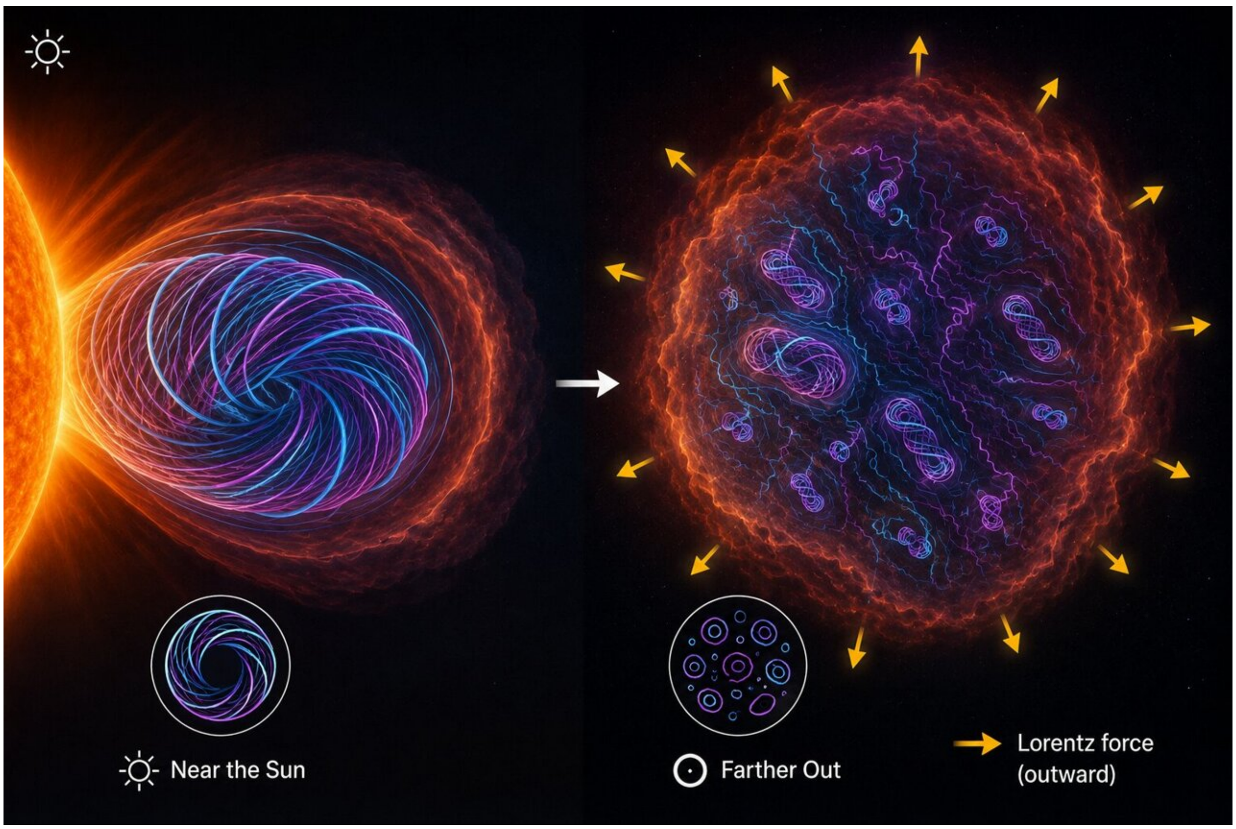


Solar Orbiter and Wind were nearly aligned along the CME's path, allowing scientists to sample the same solar storm at two different distances from the sun. This rare spacecraft geometry provided a before-and-after view of the CME's internal evolution as it traveled through space. Credit: Generated by the author using AI tools for illustrative purposes

Unraveling the magnetic core

Closer inspection of the spacecraft data revealed a dramatic change in the CME's magnetic core. The eruption was a flux rope—a twisted loop of magnetic field—and between 0.85 and 0.98 AU, it was literally tearing itself apart. The CME's large-scale twist (magnetic helicity) plummeted, showing that its organized field was disintegrating. This "topological degradation" matched predictions that fast CMEs can lose field lines to reconnection with the solar wind.

As the flux rope unwound, its stored magnetic energy cascaded into smaller scales and chaotic turbulence. Wavelet analysis showed that the turbulence inside the cloud grew immensely, but it was depleting its energy extremely quickly. This isn't just ordinary fading turbulence—the energy wasn't trickling out slowly. In fact, the CME's plasma cooled faster than if it were simply expanding adiabatically. That meant the immense turbulent energy wasn't heating the gas at all, which would have warmed it.



The CME's magnetic flux rope appears highly organized near the sun but becomes increasingly eroded and fragmented as it travels outward. The study suggests that energy released during this turbulent breakdown helps generate an outward force that can accelerate the solar storm. Credit: Generated by the author using AI tools for illustrative purposes

Turbulence takes the wheel

If the energy wasn't going into heat, where did it go? The team found that the turbulence did mechanical work on the CME. By applying an exact turbulence-energy law, they showed that virtually all the chaotic energy pumped pressure back into the cloud and pushed it outward.

"This internal energy is instead demonstrated to be converted into macroscopic mechanical work," the authors note. In effect, the internal turbulence became a hidden engine, adding an extra kick.

Put in physical terms, the relentless tearing of the flux rope weakened its magnetic tension while boosting the turbulent pressure. The result was a net outward Lorentz force on the CME. As one researcher explains, the combined "turbulent degradation and magnetic erosion of the flux rope act as the physical 'motor' that provides the extra internal pressure needed to overcome the aerodynamic solar wind drag." The storm was self-propelled: Its own messy interior drove its surprising speed.

Forecasting the unforeseeable

This discovery has important implications. It suggests that some CMEs carry a built-in turbocharger, not just slick drag. In practical terms, that means space weather models need to account for internal turbulence, not just ambient solar wind.

"Ultimately, this study proves that anomalous CME kinematics in the inner heliosphere cannot be fully comprehended without accounting for the turbulent decay and topological erosion of their magnetic structures," the authors conclude. By including these effects, forecasts of CME arrival times and strengths could become more reliable.

Future work will apply this analysis to more events and improve models. The idea is to combine multiple spacecraft and advanced physics, possibly with machine learning, to capture the CME's inner life in real time. Better understanding this hidden engine will help us predict when and how hard a solar storm will hit Earth—crucial knowledge for protecting satellites, power grids and astronauts.

More information: Daniele Telloni et al, Disentangling the Anomalous Acceleration of Coronal Mass Ejections via Turbulent Energy Conversion, *The Astrophysical Journal Letters* (2026). DOI: 10.3847/2041-8213/ae73ff