

Space Physics Fall Seminar Series

New Physics of Alfvén Waves Discovered by Parker Solar Probe

Near the Sun, Parker Solar Probe encounters large-amplitude Alfvénic fluctuations and abrupt magnetic-field reversals known as switchbacks. What three-dimensional wave structure could produce these one-dimensional spacecraft signatures?

Building on our recent paper, I will introduce the Alfvénon: a numerical realization of a solitary Alfvén wave with an undisturbed far field, open magnetic-field-line topology, and nearly constant magnetic-field strength. A spacecraft crossing its curved field lines can record a switchback-like reversal, while direct ideal-MHD simulations show coherent propagation over the simulated interval. This provides a testable physical picture of switchbacks without claiming that one structure explains every event or remains stable indefinitely.

I will also discuss how AI assisted the discovery: exploratory work with Claude helped us formulate an alternating-projection method for constructing the constrained magnetic geometry and aided code debugging. We independently implemented and tested the method, checked its physical constraints, ran the simulations, and interpreted the results. Together, these results mark a fundamental advance in Alfvén-wave physics and open a new way to study nonlinear magnetic structures across the solar wind and other magnetized plasma environments.



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Thursday, October 1
3:30 - 4:30 PM
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