Generation and Expansion-Driven Growth of Switchbacks in the Outer Solar Corona and Solar Wind

Nikolaos Sioulas[1]

[1]Imperial College London, London, United Kingdom

We analyze Parker Solar Probe and Solar Orbiter observations to examine the emergence and evolution of magnetic-field reversals (switchbacks) in the context of finite-amplitude Alfvénic wavepackets advected through an inhomogeneous, accelerating solar wind. Wave-action conservation provides the baseline scaling of fluctuation amplitudes with the Alfvénic Mach number, $M_a = U/V_a$; deviations quantify the net effect of amplification versus dissipation. The measurements separate across the Alfvén surface ($M_a = 1$): below it ($M_a < 1$) amplitudes evolve in a WKB-like, wave-action–consistent manner and inferred damping lengths are large, implying weak dissipation and conditions favorable for expansion-driven growth toward large rotations, while above it ($M_a > 1$) the evolution departs from wave-action scaling with clear scale dependence, consistent with turbulent processing. We further show that the commonly reported sub-Alfvénic "dropout" of switchbacks is methodological—driven by conditioning on instantaneous M_a inflated during strong deflections and by short-window background fields that suppress measured angles—and disappears when M_a and reference fields are defined in a stream-scale, event-independent way. Overall, the observations are consistent with a formation pathway in which coronal fluctuations are amplified by large-scale expansion through the sub-Alfvénic regime, with subsequent propagation into the super-Alfvénic wind where turbulent decay modifies their scale-dependent properties.