Whole-Sun solar jet model to study switchback formation and properties

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Résumé

Switchbacks are magnetic field deflections observed by Parker Solar Probe and remain a puzzling phenomenon in solar wind physics. While their origins are still debated and several mechanisms are under study, recent work by Touresse et al., 2024 showed that a propagating solar jet can produce such magnetic deflections that can help in understanding the observable properties of switchbacks. While none of their simulations produced a full reversal switchback, they noted that the angle of deflection depends on the plasma beta profile, i.e., the radial magnetic field decay profile. This raises the question of the influence of the magnetic field profile on the formation and properties of switchbacks.
We extend this investigation by developing new numerical experiments that aim to study the propagation of a self-induced coronal jet in a more realistic magnetic configuration including the whole 3D magnetic corona. In this study, we simulate solar jets embedded in an equatorial coronal hole using two distinct magnetic field profiles, one decreasing as 1/rˆ2 and another as 1/rˆ3. The simulation in the 1/rˆ2 profile serves as a reference case to the work of Touresse et al., 2024, while the 1/rˆ3 configuration represents a new setup.
The 3D MHD simulations rely on the Adaptive Refined MHD Solver (ARMS) code. After a relaxation phase, an untwisting magnetic jet is self-consistently generated through interchange magnetic reconnection following sub-alfvénic and sub-sonic photospheric flow at the line-tied solar surface boundary. We show that from these original whole-Sun 3D MHD simulations we create solar jets that propagate into the heliosphere, generating switchback signatures.

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