Nonlinear analysis of jet/wake and current sheet interactions in the heliospheric plasma

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The interactions between a stream and a current sheet is the starting point to understand the dynamics and evolution of complex structures in the Heliospheric region. We used 2.5D simulations to analyze the magnetohydrodynamic instabilities arising from an initial equilibrium configuration consisting of a plasma jet or wake in the presence of a magnetic field with strong transverse gradients, such as those arising in the solar wind both close to the Sun and far from it.

Our analysis extends previous results by considering both a force-free equilibrium and a pressure-balance condition for a jet in a plasma sheet, along with arbitrary angles between the magnetic field and velocity field. In the force-free case, the jet/wake does not contain a neutral sheet but the field rotates through the flow to invert its polarity. The presence of a magnetic field component aligned with the jet/wake destroys the symmetric nature of the fastest growing modes, leading to asymmetrical wake acceleration (or, equivalently, jet deceleration). In the case of a jet, the instability properties depend both on the magnetic field and flow gradients, as well as on the length of the jet.

We applied our results to the wake model of the solar wind on the solar equatorial plane above the helmet streamer cusp considering arbitrary angles between the magnetic field and the velocity field and to the post-termination shock jet recently found in 3D global heliospheric simulations, where our analysis confirms and explains the stability properties found in such simulations.