Efficient non-thermal particle acceleration mediated by the current-driven kink instability in jets

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Astrophysical jets are powerful sources of radiation across the entire electromagnetic spectrum. Yet, the basic physics underlying their particle acceleration and radiation emission are not fully understood. MHD simulations suggest that the development of the current-driven kink instability (KI) can play an important role in the dissipation of the jet's internal magnetic field, but it is not clear if such process could lead to efficient non-thermal particle acceleration. In this work, we use 3D particle-in-cell simulations to investigate the self-consistent particle acceleration associated with the development of the current-driven kink instability (KI) in magnetic field geometries relevant to relativistic jets. We find that the development of the KI mediates the efficient dissipation of the magnetic field into high-energy particles. Non-thermal particles are accelerated by the combination of a coherent inductive electric field that develops at the core of the current flow during the nonlinear stage of the KI and efficient scattering in the highly tangled magnetic fields. This results in a spectral power-law tail that is robust for a large range of initial conditions and system sizes. We determine scaling laws for this process with system size and magnetization, and discuss the implications of our results for relativistic astrophysical jets. Finally, we will discuss the possibility of exploring this physics in HED laboratory experiments.