Nonthermal particle acceleration in magnetized kink-unstable jets

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Highly-magnetized relativistic jets from active galaxies are among the most powerful cosmic particle accelerators. It is thought that MHD instabilities, such as the kink mode, can play an important role in the dissipation of the jet's magnetic energy. Using large-scale 3D particle-in-cell simulations we study particle acceleration in kink-unstable jets starting from force-free equilibria. We find that the kink instability can trigger very efficient conversion of the toroidal magnetic field energy into nonthermal particles. The acceleration proceeds in a two-step process. First, jet distortions give rise to elongated current sheets and particles are injected/pre-accelerated via magnetic reconnection in these regions. These particles can then be significantly energized by magnetic turbulence produced during the nonlinear stage of the kink instability. We find that this second, and dominant, acceleration phase is mediated by particle curvature drift motions along ideal electric fields. The nonthermal particles develop a power-law energy spectrum with an index that approaches ~1.75 for high-magnetizations and consistently reach the jet's confinement energy for increasing jet radii. These results help establish the kink instability as an important mechanism to trigger efficient nonthermal particle acceleration in relativistic astrophysical jets.