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Dynamical energy dissipation of relativistic magnetic jets

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Relativistic outflows or jets with more than 99% of the light speed emerge in pulsar wind nebulae, gamma-ray bursts, and active galactic nuclei. Such relativistic jets are thought to be launched through magnetic processes, which implies magnetically dominated outflows. However, a multi-wavelength spectrum suggests that jets must be kinetically dominated at the gamma-ray emission region. This means the magnetic energy should dissipate into the thermal energy while propagation. Although the traditional shock dissipation mechanism so-called internal shock is thought to be inefficient for magnetically dominated ejecta, a kinetically dominated matter between ejecta may play an important role in magnetic energy dissipation by shock waves.

We demonstrate the efficient internal shock dissipation through the multiple interactions between magnetically dominated relativistic ejecta with kinetically dominated winds by performing our spherically symmetrical 1-Dimensional Special Relativistic Magneto-HydroDynamic (1D SRMHD) simulation code with adaptive mesh refinement. Our numerical results show that almost 10% of the magnetic energy in the ejecta can be converted into the thermal energy of the relativistic and low-magnetized outflows via shocks in the rarefaction waves or the winds. Such hot and less magnetized outflows are relevant for observed non-thermal emissions in blazars or gamma-ray bursts.

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