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Extreme particle acceleration at AGN jet termination shocks

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Extragalactic plasma jets are some of the few astrophysical environments able to confine ultra-high energy cosmic rays, but whether they are capable of accelerating these particles is unknown. In this work, we revisit particle acceleration at relativistic magnetized shocks beyond the local uniform field approximation, by considering the global transverse structure of the jet. Using large two-dimensional particle-in-cell simulations of a relativistic electron-ion plasma jet, we show that the termination shock forming at the interface with the ambient medium accelerates particles up to the confinement limit. The radial structure of the jet magnetic field leads to a relativistic velocity shear that excites a von Kármán vortex street in the downstream medium trailing behind an over-pressured bubble filled with cosmic rays. Particles are efficiently accelerated at each crossing of the shear flow boundary layers. These findings support that extragalactic plasma jets may be capable of producing ultra-high energy cosmic rays. This extreme particle acceleration mechanism may also apply to microquasar jets.

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