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A new mechanism for relativistic particle acceleration via wave-particle interaction GIOVANNI LAPENTA, LANL, STEFANO MARKIDIS, UIUC, ALBERTO MAROCCHINO, Imperial College — Often in laboratory, space and astrophysical plasma, high energy populations are observed. Two puzzling factors still defy our understanding. First, such populations of high energy particles produce power law distributions that are not only ubiquitous but also persistent in time. Such persistence is in direct contradiction to the H theorem that states the ineluctable transition of physical systems towards thermodynamic equilibrium, and ergo Maxwellian distributions. Second, such high energy populations are efficiently produced, much more efficiently than processes that we know can produce. A classic example of such a situation is cosmic rays where power alws extend up to tremendolus energy ranges. In the present work, we identify a new mechanism for particle acceleration via wave-particle interaction. The mechanism is peculiar to special relativity and has no classical equivalent. That explains why it is not observed in most simulation studies of plasma processes, based on classical physics. The mechanism is likely to be active in systems undergoing streaming instabilities and in particular shocked systems. The new mechanism can produce energy increases vastly superior to previously known mechanisms (such as Fermi acceleration) and can hold the promise of explaining at least some of the observed power laws.

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