A PURELY RELATIVISTIC MECHANISM FOR PARTICLE ACCELERATION BY WAVE-PARTICLE INTERACTION

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The present work aims at describing how the equations of special relativity allow by their very nature the efficient acceleration of particles via wave-particle interaction. The effect is due directly to the metric of the Minkowski space-time that creates the conditions for efficient particle acceleration by localized electric fields. This purely relativistic effect will be the main topic of the presentation.

To highlight the effect we simulate the acceleration of electrons to relativistic energies due to the interaction of electrons with waves generated by longitudinal (i.e., electrostatic) streaming instabilities in plasmas. While electrostatic fluctuations are considered here, the same effect has also been demonstrated in presence of transverse electromagnetic wave-particle interactions.

We consider two identical systems undergoing a streaming instability, one according to the classical Newton law and one according to the special relativity dynamics equation. The system that obeys Newton law relaxes to a Maxwellian equilibrium distribution. In the case of the relativistic dynamics, the relaxed phase space distribution exhibits intermittent peaks at high momenta and a larger number of particles at high energies.

This electron population at higher energies could explain power-law energy distribution in many plasma physics and astrophysical systems. The results obtained in the simulations confirm the recent theory by Kaniadakis that predicts the statistical nature of a relaxed relativistic system (G. Kaniadakis, *Phys. Rev. E*, **66**, 056125, 2002)

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