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On stability properties of the numerical Cherenkov instability in relativistic plasma flows

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We examined stability properties of the numerical Cherenkov instability in relativistic plasma flows. Particle-in-cell simulation code package, pCANS, was used for the numerical analysis. With the implicit FDTD method for Maxwell equations, we found that the instability was greatly inhibited with the CFL number of 1.0. Numerical tests with various CFL numbers ranging from 0.5 to 1.0 showed that the growth rate remarkably decreased at CFL = 1.0 following a gradual decrease from the value at CFL=0.5. The implicitness factor (alpha=0.5 for Clank-Nicolson method) was also found to control the width of the dip. The present result contrasts with the recently reported results (Vay et al., 2011, Godfrey & Vay, 2013) in which the magical CFL number were 0.5 and 0.7 respectively for their different explicit field solvers. We present the result with the detailed dispersion relation of the implicit field solver and its application to relativistic collisionless shock simulations.

Keywords: particle-in-cell simulation, relativistic plasma, numerical Cherenkov radiation, shocks