[JJ] Evening Poster | P (Space and Planetary Sciences) | P-EM Solar-Terrestrial Sciences, Space Electromagnetism & Space Environment

[P-EM17]Space Plasma Physics: Theory and Simulation

convener:Takayuki Umeda(Institute for Space-Earth Environmental Research, Nagoya University), Yohei Miyake(Education Center on Computational Science and Engineering, Kobe University), Yasuhiro Nariyuki(富山大学人間発達科学部, 共同), Tadas Nakamura(Fukui Prefectural University)

Wed. May 23, 2018 5:15 PM - 6:30 PM Poster Hall (International Exhibition Hall7, Makuhari Messe)

This session focuses on studies of space plasma physics via theoretical and numerical approaches. Papers on a wide variety of topics from natural phenomena to artificial plasma environment as well as theoretical and computational methodologies are welcome.

[PEM17-P01]Mitigation of the numerical Cherenkov instability by using the Cole-Karkkainen field solver for PIC simulations

*Yosuke Matsumoto[1] (1.Graduate School of Science, Chiba University)

Keywords:numerical Cherenkov instability, relativistic shock, PIC simulation

Particle-in-cell simulations have been used for understanding particle accelerations at collisionless shocks. A numberical instability, however, becomes problematic in particular for relativistic situations, such as relativstic shock simulations. The instability arises from the numerical dispertion of the light wave under a plasma flow with relativistic speeds, and has been known as the numerical Cherenkov instability (NCI) since Godfrey [1976]. To tackle this problem, digital filtering techniques along with the 4th order electromagentic field solver have been used to suprress the instability. Drawback of the filtering techniques is that they also damp physical waves, which is critical in particular for collisionless shock simulations.

We have developed a technique to mitigate the NCI for relativistic shock simulations by adopting a specific CFL number with a special combination of the PIC algorithms (Vay &Godfrey, 2013; Xu et al., 2013; Ikeya &Matsumoto, 2015). We have confirmed this novel properties of mitigating the NCI for highly relativistic cases (the Lorentz factor gamma >10, Iwamoto et al., 2017), but for mildly relativistic cases (gamma <5). In this presentation, we present another implementation of the technique using Cole-Karkkainen electromagnetic field solver (Cole, 2002; Karkkainen et al., 2006; Vay et al., 2011). We derived a dispersion relation of an implicit C-K solver and confirmed the implementation into our 2D PIC code. We found that the implicit C-K solver has novel properties of mitigating the NCI not only for ultra relativistic cases, but also for mildly relativistic cases (gamma=2). We present detailed properties of this scheme along with an application to relativistic shock simulations.