Toroidal Electromagnetic Particle-in-Cell Code with Gyro-kinetic Electron and Fully-kinetic ion

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A Particle-in-Cell toroidal simulation code is implemented, with a newly developed kinetic model adopting fully-kinetic ion and gyro-kinetic electron. In this simulation model, electron’s fast gyro motion is systematically removed using Lie-transform perturbation theory. This code is developed in general magnetic flux coordinate and field-line coordinate, which is suitable for simulations of toroidally confined plasma. Two core components – single particle pushing and field solver are successfully verified. Integrated ElectroStatic benchmark with lower-hybrid wave (LHW) and ion Bernstein wave (IBW) matches well with theoretical estimation. This code can be a first-principal tool to investigate high frequency nonlinear phenomenon, such as parametric decay instability (PDI), during lower-hybrid current drive (LHCD) and ion cyclotron radio frequency heating (ICRF) with complex geometry effect included.