Abstract Submitted
for the DPP19 Meeting of
The American Physical Society

A multiscale semi-Lagrangian algorithm for fast-electron transport in the relativistic Vlasov-Fokker-Planck equation. DON DANIEL, LUIS CHACON, WILLIAM TAITANO, Los Alamos National Laboratory — In tokamaks, relativistic runaway electrons traverse orbits at much faster time scales than collisional ones while dynamic scales of interest span over time scales much longer than those. Therefore, accurate and efficient modeling of orbit dynamics beyond collisional timescales is essential to model runaway dynamics in tokamaks. Common strategies to deal with this scale separation are based on bounce averaging, which is brittle and not generalizable to arbitrary 3D magnetic field configurations. In this study, we use a semi-Lagrangian scheme to bridge these scales. The approach reformulates the Vlasov equation as an integro-differential operator using Greens functions, and then selectively approximates the integrals and uses operator splitting to make the method tractable (similarly to what was done in Ref. [1] for anisotropic diffusion). The proposed 1D-2V treatment is first-order accurate in time but promises to (i) preserve asymptotic properties associated with stiff Vlasov term, (ii) be uniformly accurate in ϵ, where ϵ is the ratio of advection to collisional time scales, and also (iii) be optimal (i.e. scalable) with the total mesh points in the domain. We will demonstrate the algorithm with realistic applications of interest.
[1] Chacon et al., JCP, 272 (2014)

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Date submitted: 03 Jul 2019 Electronic form version 1.4