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A non-stochastic Coulomb collision algorithm for particle-in-cell methods GUANGYE CHEN, LUIS CHACON, LANL — Coulomb collision modules in PIC simulations are typically Monte-Carlo-based. Monte Carlo is attractive for its simplicity, efficiency in high dimensions, and conservation properties. However, it is noisy, of low temporal order (typically $O(\sqrt{\Delta t})$, and has to resolve the collision frequency for accuracy.[1] In this study, we explore a non-stochastic, multiscale alternative to Monte Carlo for PIC. The approach is based on a Green-function-based reformulation[2] of the Vlasov-Fokker-Planck equation, which can be readily incorporated in modern multiscale collisionless PIC algorithms.[3] An asymptotic-preserving operator splitting approach allows the collisional step to be treated independently from the particles while preserving the multiscale character of the method. A significant element of novelty in our algorithm is the use of a machine learning algorithm that avoid a velocity space mesh for the collision step.[4] The resulting algorithm is non-stochastic and first-order-accurate in time. We will demonstrate the method with several relaxation examples.

[1]Dimits, et. al., JCP, 228, p.4881 (2009)
[2]Hu, Krommes, PoP, 1, p. 863 (1994)
[3]Chen, Chacón, and Barnes, JCP, 230, p.7018 (2011)
[4]Yoon and Chang, PoP, 21, 032503 (2014)

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