High-order leapfrog scheme of the Vlasov-Ampère system for the electrostatic plasma

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The simulation result of Vlasov code has high signal-to-noise ratio, in comparison to PIC (particle-in-cell) code. In the past, due to the scarcity of computing power, most researchers use PIC code as a tool toward novel explorations and investigations. With the rapidly enhancement in computing power of supercomputers, the high resource-demanding Vlasov simulation of potency has become wildly adoptable and efficiently achievable. In this study, we adopt grid-base Eulerian solver, instead of the customary semi-Lagrangian method, to solve Vlasov-Ampère equations for electrostatic plasma. We use three-step high-order leapfrog scheme for the solutions of energy-conserving Vlasov-Ampère equations. We use fifth-order central finite difference method to calculate the first derivative in Vlasov equation along the real space. We use cubic spline method to calculate the first derivative and integration along velocity space in the Vlasov equation and Ampère law without magnetic field, respectively. We use forth-order leapfrog method for time stepping. Subsequently, we examine the correctness of grid-base Eulerian solver in solving Vlasov-Ampère equations for electrostatic plasma by linear Landau damping test.

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