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Full-electromagnetic Vlasov simulations with the Multi-Moment Advection scheme

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The Vlasov simulation, which solves the advection equation of the distribution function in phase space, has been proposed for an alternative method of the Particle-In-Cell (PIC) method, to overcome some problems inherent to the PIC. However, suitable methods for the Vlasov simulation have not been established so far, because of the difficulty to accurately solve the advection equation in multidimensions.

We have developed a numerical scheme that enables us to solve the advection equation with quite little numerical diffusion. The scheme is designed to treat not only point values of a profile but also its zeroth to second order piecewise momenta as dependent variables, for better conservation of the information entropy. We have reported one- and two-dimensional schemes and their successful applications to electrostatic and electromagnetic Vlasov simulations.

However, many plasma phenomena of interest require to treat the full three-dimensional velocity space distribution. Therefore we develop the three-dimensional scheme. As well as the one- and two-dimensional schemes, the scheme also provides quite accurate solutions of linear advection and solid-body rotation problems. This is the most important capability for Vlasov simulations of magnetized plasmas.

In this presentation, we show the design of the schemes in detail. We will show some benchmark tests of Vlasov simulations of magnetized plasmas with the scheme in the three-dimensional velocity space.

Keywords: Vlasov simulations