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Particle Methods for Revealing Kinetic Plasma Behavior¹

BENJAMIN YEE, M.M. HOPKINS, Sandia National Laboratories

Particle methods are appealing tools for modeling the behavior of plasmas for several reasons. Their implementation can be extremely simple both in terms of the physical models and the numerical methods. However, despite this simplicity they are capable of reproducing complex plasma dynamics. From a pedagogical perspective, they provide an appreciation for the connection between the microscopic view of a plasma and its characteristic collective effects. The primary downsides of particle methods are their computational cost and the stochastic nature of their output. This talk will review the foundational principles of the particle-in-cell (PIC) method and basic numerical methods required for its implementation. From there, some of the basic constraints for accurate solutions will be presented, followed by a hands-on demonstration of using a PIC code to simulate the two-stream instability. The results from this simulation will then be compared to the analysis of the instability and the fluid results. By the end of this talk, attendees can expect to learn the essential components of PIC codes, important considerations in interpreting their results, and publicly available resources.

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