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Time-discretized action principle variational formulation of finite-size particle simulation methods for electrostatic plasmas[1] BRADLEY SHADWICK, University of Nebraska - Lincoln, EVSTATI EVSTATIEV, FAR-TECH, Inc. — We formulate finite-size particle plasma simulation methods from a time-discretized action principle viewpoint. Using Low's Lagrangian as a starting point, we first discretized in spatially the continuous fields and formulate a time-continuous action for the self-consistent system of particles and fields in the electrostatic (ES) plasma approximation. We then utilize a technique due to Lew et. al. [1] to formulate time-discrete action and its variation to obtain a particular time integrator. Such time integrators are symplectic (provided there is symmetry with respect to time inversion); they do not conserve energy exactly but the energy variation is bounded and its magnitude depends on the time step. These general time integrators can be of any order of accuracy, however as a rule, beyond second order they are implicit. Time-implicit schemes are easy to formulate for the general cases of electromagnetic and magnetized plasmas. We provide numerical examples of both explicit and implicit time integrators and discuss their advantages and disadvantages.

[1] A. Lew, J. E. Marsden, M. Ortiz, and M. West. International Journal for Numerical Methods in Engineering 60(1), 153-212, 2004.

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