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Particle algorithms as reductions of phase space[1] EVSTATI EVSTATIEV, FAR-TECH, Inc., BRADLEY SHADWICK, University of Nebraska - Lincoln — Particle-In-Cell (PIC) algorithm for simulation of plasmas has become a basic tool for investigating laser-plasma interactions, MHD phenomena, etc. Historically, there have been two "branches" of the PIC algorithm, energy conserving and momentum conserving. The momentum conserving algorithm has been more widely adopted so far, however, energy conserving algorithms (including implicit schemes) are being investigated actively. Many physics phenomena depend crucially on the energy conserving property; for example, wave-particle resonance is sensitive to the energy distribution of particles and thus some numerical artifacts, e.g., grid heating, lead to large variation of the simulation results. In this presentation we revisit the connection between momentum and energy conserving algorithms. We show that they essentially are different reductions from the same initial continuous model. We derive a hierarchy of particle algorithms with properties depending on the approximations made; we show what conditions lead to energy or momentum conservation, or how to derive particle algorithms, which conserve both energy and momentum. We present simulations substantiating the above theory.

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