Abstract Submitted
for the DPP17 Meeting of
The American Physical Society

Metriplectic Gyrokinetics and Discretization Methods for the Landau Collision Integral[1] EERO HIRVIJOKI, Princeton Plasma Physics Laboratory, JOSHUA W. BURBY, Courant Institute of Mathematical Sciences, MICHAEL KRAUS, Max Planck Institut für Plasma Physik — We present two important results for the kinetic theory and numerical simulation of warm plasmas: 1) We provide a metriplectic formulation of collisional electrostatic gyrokinetics that is fully consistent with the First and Second Laws of Thermodynamics. 2) We provide a metriplectic temporal and velocity-space discretization for the particle phase-space Landau collision integral that satisfies the conservation of energy, momentum, and particle densities to machine precision, as well as guarantees the existence of numerical H-theorem. The properties are demonstrated algebraically. These two result have important implications: 1) Numerical methods addressing the Vlasov-Maxwell-Landau system of equations, or its reduced gyrokinetic versions, should start from a metriplectic formulation to preserve the fundamental physical principles also at the discrete level. 2) The plasma physics community should search for a metriplectic reduction theory that would serve a similar purpose as the existing Lagrangian and Hamiltonian reduction theories do in gyrokinetics. The discovery of metriplectic formulation of collisional electrostatic gyrokinetics is strong evidence in favor of such theory and, if uncovered, the theory would be invaluable in constructing reduced plasma models.

[1]Supported by U.S. DOE Contract Nos. DE-AC02-09-CH11466 (EH) and DE-AC05-06OR23100 (JWB) and by European Unions Horizon 2020 research and innovation grant No. 708124 (MK)

Eero Hirvijoki
Princeton Plasma Physics Laboratory

Date submitted: 13 Jul 2017 Electronic form version 1.4