Abstract Submitted
for the DPP19 Meeting of
The American Physical Society

Geometric theory of Klimontovich representation and structure-preserving geometric particle-in-cell algorithms[1] HONG QIN, ALEXANDER S. GLASSER, Princeton University — Structure-preserving geometric algorithms in plasma physics [1] numerically preserve the structures of physical systems, such as the local energy-momentum conservation law, symplectic structure, and gauge symmetry, for arbitrarily large number of simulation time-steps. They possess long-term accuracy and fidelity and are especially suited for exascale hardwares. Their advantages over conventional algorithms have been amply demonstrated. A key component of the structure-preserving geometric particle-in-cell algorithms [2-4] is the geometric theory of the Klimontovich representation, which geometrically discretizes the Poisson structure on the infinite dimensional dual of the Lie algebra of distribution densities as [3]

$$\int f\{\frac{\delta H}{\delta f},\frac{\delta G}{\delta f}\}_{xp}dxdp=\sum_{i=1}^{N}\left(\frac{\delta h}{\delta X_i}\frac{\delta g}{\delta P_i}-\frac{\delta g}{\delta X_i}\frac{\delta h}{\delta P_i}\right).$$

More fundamentally, the geometric theory of the Klimontovich representation establishes a symplectic structure for the Vlasov-Maxwell system from the first principles of physics. [1] Qin et al., PRL 100, 035006 (2008). [2] Squire et al., PoP 19, 084501 (2012). [3] Qin et al., Nucl. Fusion 56, 014001 (2016). [4] Xiao et al., PoP 22, 112504 (2015).

[1]Supported by the U.S. DOE (DE-AC02-09CH11466).

Hong Qin
Princeton University

Date submitted: 03 Jul 2019 Electronic form version 1.4