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A New Algorithm for Plasma Simulations that Exactly Conserves Energy-Momentum and Charge[1] ALEXANDER S. GLASSER, HONG QIN, Princeton Plasma Physics Laboratory and Princeton University — Because the space-times of algorithms are necessarily discrete, and the Noether symmetries they model necessarily continuous, energy-momentum conservation laws are generally broken in any first principles plasma simulation. In this work, we take up this central challenge of computational physics and develop an algorithm that exactly preserves Poincare and $U(1)$ symmetry. Relinquishing Lagrangian and Hamiltonian formalisms, our approach employs a new dynamical formalism for classical lattice gauge theory, in which we solve Yang-Mills-type equations for gauge groups of reductive Cartan geometries. We investigate the applicability of this algorithm to a range of physical systems, including high energy density plasmas and astrophysical plasmas evolving under gravity in curved space-time.

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Alexander Glasser
Princeton Plasma Physics Laboratory

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