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**A One-Step Variational Guiding Center Integrator using Toroidal Regularization**[1] C LELAND ELLISON, Lawrence Livermore National Laboratory, Livermore, CA 94550, JOSHUA BURBY, Courant Institute of Mathematical Sciences, New York, NY 10012 — Guiding center and gyro-center particle advances — central to test particle, drift-kinetic, and gyro-kinetic simulations — stand to benefit from symplectic integration techniques, which have had a profound impact in other physics disciplines. The non-canonical Hamiltonian formulation of these systems has kept such symplectic integration thus far elusive, except for in restricted magnetic geometries or by using computationally expensive transformations to canonical coordinates. In this work, we perform a near-identity Lie transformation to the guiding center coordinates to obtain a "toroidally regularized" Lagrangian for which symplectic integration can be more readily achieved. This transformation also eliminates the effective magnetic field appearing in the denominator of the guiding center equations and correspondingly eliminates the large parallel velocity singularities from the equations. The recently developed technique of degenerate variational integration is then applied to the regularized Lagrangian to obtain a one-step variational integrator valid for any magnetic geometry with non-zero toroidal magnetic field.

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