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Variational Integrators for Ideal and Reduced Magnetohydrodynamics MICHAEL KRAUS, OMAR MAJ, Max Planck Institute for Plasma Physics, EMANUELE TASSI, Aix-Marseille Universit, Universit de Toulon, CNRS, CPT, UMR 7332, DANIELA GRASSO, ISC-CNR and Politecnico di Torino, Dipartimento Energia — Ideal and reduced magnetohydrodynamics are simplified sets of magnetohydrodynamics equations with applications to both fusion and astrophysical plasmas, possessing a noncanonical Hamiltonian structure and a number of conserved functionals. We propose a new discretisation strategy for these equations based on a discrete variational principle applied to a formal Lagrangian. Discrete exterior calculus is used for the discretisation of the field variables in order to preserve their geometrical character. The resulting integrators preserve important quantities like the total energy, magnetic helicity and cross helicity exactly (up to machine precision). As these integrators are free of numerical resistivity, the magnetic field line topology is preserved and spurious reconnection is absent in the ideal case. Only when effects of finite electron mass are added, magnetic reconnection takes place. The excellent conservation properties of the methods are exemplified with numerical examples in 2D. We conclude with an outlook towards the treatment of general geometries in 3D and full magnetohydrodynamics.

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