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Magnetic helicity transport in the advective gauge family

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Magnetic helicity fluxes are investigated in a family of gauges in which the contribution from ideal magnetohydrodynamics takes the form of a purely advective flux. Numerical simulations of magnetohydrodynamic turbulence in this advective gauge family exhibit instabilities triggered by the build-up of unphysical irrotational contributions to the magnetic vector potential. As a remedy, the vector potential is evolved in a numerically well behaved gauge, from which the advective vector potential is obtained by a gauge transformation. In the kinematic regime, the magnetic helicity density evolves similarly to a passive scalar when resistivity is small and turbulent mixing is mild, i.e. when the fluid Reynolds number is not too large. In the dynamical regime, resistive contributions to the magnetic helicity flux in the advective gauge are found to be significant owing to the development of small length scales in the irrotational part of the magnetic vector potential.

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