Nonlinear interfacial motion in magnetohydrodynamic flows

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A theoretical model is proposed to describe the nonlinear dynamics of interfaces in two-dimensional MHD flows. Numerical calculations based on the current-vortex sheet model are applied to MHD Richtmyer-Meshkov instability (MHD RMI) with sinusoidal vortex sheet strength. RMI is important in various areas such as astrophysical supernova, supersonic combustion, atmospheric flows, unsteady boundary layers, inhomogeneous MHD turbulence, and the inertial confinement fusion. RMI can also take place when supernova shocks pass through the interstellar medium, and it causes the magnetic field amplification in supernova remnants. In the current study, we show that the magnetic field amplification is caused by the nonlinear dynamics of the non-uniform current-vortex sheet. We also show that the magnetic tension stabilizes the interfacial instability. Our model can apply to a wide variety of MHD shear flows such as MHD Kelvin-Helmholtz instability and MHD Rayleigh-Taylor instability.