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Nonlinear Instabilities on an Axisymmetric Ferrofluid Jet
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— The stability properties of an inviscid axisymmetric ferrofluid jet running over a current carrying rod are investigated. The rod generates an azimuthal magnetic field which can fully stabilize the Rayleigh-plateau instability for a sufficiently large magnetic field. However, long wave instability can occur when the magnetic field is below critical; this regime has not been studied nonlinearly unlike the above critical regime where the magnetic stabilization property has led to theoretical and experimental discoveries of solitary waves on the ferrofluid jet. We study the flow asymptotically near the critical value of the magnetic field. In the stable regime, we derive the Boussinesq equation. Our interest is in the unstable regime, where magnetic forces are slightly smaller than capillary forces. The Rayleigh-plateau instability is no longer suppressed and a weakly nonlinear long wave model is derived and studied analytically and computationally. The final part of the study follows the nonlinear evolution of the free surface for magnetic fields away from the critical level. A fully nonlinear long-wave theory will be used to derive reduced model equations to evaluate the nonlinear competition between capillary instability of the liquid jet and the stabilizing magnetic field.

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