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Dynamics of a thin ferrofluid film subjected to a magnetic field

DEVIN CONROY, ALEX WRAY, OMAR MATAR, Imperial College London — We consider a thin film flowing down a rigid, impermeable inclined plane subjected to a magnetic field. The film corresponds to a ferrofluid and is bounded from above by a hydrodynamically-passive gas. The ferrofluid is considered to be weakly-conducting, and its dynamics are governed by the steady Maxwell's equations, coupled to the Navier-Stokes, and continuity equations. The magnetisation of the ferrofluid is a function of the magnetic field, which can be represented by a nonlinear Langevin function. We use long-wave theory to determine the velocity and pressure fields in the film, and use Fourier transforms to solve for the potential field in the gas phase. Application of the interfacial and kinematic boundary conditions then leads to a one-dimensional partial differential equation for the interface with a non-local contribution from the magnetic effects. A linear stability analysis of this equation is carried out. This equation is then solved numerically for a wide range of system parameters. The results of this parametric study will be presented.

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