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Three-dimensional wave evolution on electrified falling films. RUBEN TOMLIN, DEMETRIOS PAPAGEORGIOU, GREG PAVLIOTIS, Imperial College London — We consider the full three-dimensional model for a thin viscous liquid film completely wetting a flat infinite solid substrate at some non-zero angle to the horizontal, with an electric field normal to the substrate far from the flow. Thin film flows have applications in cooling processes. Many studies have shown that the presence of interfacial waves increases heat transfer by orders of magnitude due to film thinning and convection effects. A long-wave asymptotics procedure yields a Kuramoto-Sivashinsky equation with a non-local term to model the weakly nonlinear evolution of the interface dynamics for overlying film arrangements, with a restriction on the electric field strength. The non-local term is always linearly destabilising and produces growth rates proportional to the cube of the magnitude of the wavenumber vector. A sufficiently strong electric field is able promote non-trivial dynamics for subcritical Reynolds number flows where the flat interface is stable in the absence of an electric field. We present numerical simulations where we observe rich dynamical behavior with competing attractors, including "snaking" travelling waves and other fully three-dimensional wave formations.

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