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Nonlinear Pattern Selection in Bi-Modal Interfacial Instabilities[1]
JASON PICARDO, Department of Chemical Engineering, Indian Institute of Technology Madras, RANGA NARAYANAN, Department of Chemical Engineering, University of Florida — We study the evolution of two interacting unstable interfaces, with the aim of understanding the role of non-linearity in pattern selection. Specifically, we consider two superposed thin films on a heated surface, that are susceptible to thermocapillary and Rayleigh-Taylor instabilities. Due to the presence of two unstable interfaces, the dispersion curve (linear growth rate plotted as a function of the perturbation wavelength) exhibits two peaks. If these peaks have equal heights, then the two corresponding disturbance patterns will grow with the same linear growth rate. Therefore, any selection between the two must occur via nonlinear effects. The two-interface problem under consideration provides a variety of such bi-modal situations, in which the role of nonlinearity in pattern selection is unveiled. We use a combination of long wave asymptotics, numerical simulations and amplitude expansions to understand the subtle nonlinear interactions between the two peak modes. Our results offer a counter-example to Rayleighs principle of pattern formation, that the fastest growing linear mode will dominate the final pattern. Far from being governed by any such general dogma, the final selected pattern varies considerably from case to case.

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