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Electrostatic interfacial instability: Weakly nonlinear analysis[1]
RANGA NARAYANAN, DINESH BHAGAVATULA, University of Florida — We analyse the stability of an interface between a perfectly conducting fluid in contact with a perfect dielectric under the influence of an electric field imposed normal to it. The fluids are confined between two rigid plates, which are maintained at a constant voltage difference, D, counteracting gravity. This work has its implications to patterning of polymer films, where the conducting fluid self assembles into arrays of pillars. These patterns arise due the competition between the applied voltage on the one hand and gravity and surface tension on the other. These competing effects lead to a minimum in a plot of D vs. the wavenumber, k, of the disturbance at the onset of the instability. The voltage difference and surface tension compete at high k, reminiscent of the subcritical nature of the Rayleigh-Taylor instability. However, the presence of a minimum in the D vs. k plot is indicative of a supercritical instability, much like the Benard problem. This suggests that there is a super to subcritical transition, which we investigate using a weakly nonlinear analysis about the neutral state where the applied voltage difference is advanced slightly beyond the critical point. Plots of this transition are presented as a function of the Bond number and explained.

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