The role of the transverse dimension in the instabilities and transitions of inclined film flow

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Film flows at low inclination are destabilized by an interfacial mode, whose streamwise scale is significantly larger than the mean film thickness. Theoretical predictions are based on long-wave expansions using the assumption of two-dimensional flow development. However, recent experimental findings [Vlachogiannis *& al.*, Phys. Fluids 22, 2010 ; Leontidis *& al.*, Phys. Fluids, 22, 2010] show that both the primary instability and the properties of subsequent traveling waves are significantly affected by channel width, even though the latter is 2 orders of magnitude larger than the liquid film thickness. The extent of deviation from theory depends on the physical properties of the liquid, and is conveniently quantified by the Kapitza number. The present study documents the combined effects of width and Ka, and interpretes the observed phenomena in terms of the properties of traveling waves.

Observations tend to the theoretical prediction for small Kapitza ($Ka < 100$), but deviate progressively as Ka increases and eventually reach a plateau in the limit of high Kapitza ($Ka > 2000$). The above behavior is interpreted as a competition between streamwise viscous dissipation and transverse capillary attenuation of disturbances. The plateau is reached when capillary forces dominate over viscous forces. Variations in wave height and shape along the crestline set the ground for conjectures about secondary flow fields triggered by differences in capillary pressure.