Revised Froude number for Rayleigh-Taylor flow with secondary instabilities

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Recent simulations[1] and experiments[2] have shown the late-time Rayleigh-Taylor (RT) saturation velocity is sensitive to the appearance of secondary Kelvin-Helmholtz (KH) vortices. Specifically, RT bubbles experience a late surge due to the induced velocity of the KH vortices and saturate at a Froude number twice that predicted by potential flow models[3]. We describe this picture with a simple toy model that idealizes the KH rollups as a pair of point vortices, so that the total bubble velocity is given by

$$V_b = \sqrt{\frac{2A}{1+A}\frac{g}{3k}} + \frac{\kappa}{r_{1-2}}\,.$$

In the above, the first term is the classical potential flow velocity[3], while the second term represents the induced velocity due to the KH doublet (κ is the vortex strength, while r_{1-2} is the spacing between the vortices). From classical linear theory, the KH growth rates also depend on several parameters such as viscosity, surface tension, and density difference between the fluid streams. We have studied the influence of these parameters on the fundamental RT mode, and will discuss our findings. The late time RT reacceleration was presented as a test problem at the 11th IWPCTM, in Santa Fe, USA, and this talk will summarize the results from that collaboration.

References

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