Bound state formation in falling liquid films

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ABSTRACT

Bound-state formation of falling liquid films is examined numerically by finite-element solution of the Navier-Stokes equations and free-surface boundary conditions. It is shown that the interaction between solitary pulses may give rise to the formation of bound states consisting of two or more pulses separated by well-defined distances and travelling at the same velocity, see Fig. 1. Pulse couples are studied first: Stationary solutions of the Navier-Stokes equations are sought, and the resulting equilibrium pulse distances compare favourably to theoretical predictions [1] at large and intermediate pulse separations. When the two pulses are closely spaced, theory becomes increasingly less accurate. More important, time-dependent simulations indicate that all initial conditions lead to an oscillatory variation of the close pulse-separation distance, as numerically observed in [2]. Bound states consisting of three pulses are computed next. If the pulses are symmetrically placed, equilibrium separation distances are similar to predictions based on simple couples. However, if two consecutive pulses are at the closest bound state, then this doublet equilibrates with the third pulse at distances that may deviate significantly from simple predictions. Also, the equilibrium distance is different if the third pulse is located in front or behind the doublet.

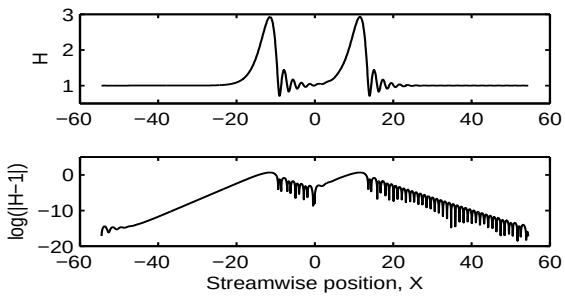

Figure 1: A two-pulse bound-state formation

References

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[2] N. A. Malamataris, M. Vlachogiannis, and V. Bontozoglou: Solitary waves on inclined films: Flow structure and binary interactions, *Physics of Fluids* **14**, 1082, 2002.