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Coherent wave structures on falling fluid films flowing down a flexible wall GRIGORI SISOEV, University of Birmingham, RICHARD CRASTER, University of Alberta, SATISH KUMAR, University of Minnesota, OMAR MATAR, Imperial College London — The dynamics of a thin fluid film flowing down a flexible vertical wall at moderate flow rates is studied in order to identify the dominant wave structures that will be observed in experiments. An asymptotic reduction using boundary-layer theory, and the von Kármán-Polhausen approximation, leads to coupled partial differential equations governing the nonlinear dynamics of the flow rate, and the gas-liquid and liquid-solid interfaces; closure is provided by a semi-parabolic fluid velocity profile. Fluid inertia, capillarity and viscous retardation effects are incorporated as are wall damping and tension. The validity of our approach is demonstrated using direct comparisons with predictions from the Orr-Sommerfeld equations. Nonlinear steady-travelling waves are identified from a nonlinear eigenvalue problem illustrating a multiplicity of solutions from which the dominating (attracting) solutions can be identified. Subsequent time-dependent numerical simulations of the fully-nonlinear partial differential equations demonstrate the selection of these dominant solutions, and, as such, they then constitute a point of direct comparison with physical experiments.

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