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Dynamics of a reactive falling film[1] SERAFIM KALLIADASIS, PHILIP TREVELYAN, Department of Chemical Engineering, Imperial College London, London SW7 2AZ, UK, PATTERN FORMATION AND NONLINEAR DYNAMICS GROUP TEAM — We study the dynamics of a falling film in the presence of a first-order (exothermic or endothermic) chemical reaction. The heat released or absorbed by the reaction alters the surface tension, which in turn affects the evolution of the film, which in turn affects the rate of reaction and therefore the heat released by the reaction (feedback). Our analysis is based on an integral-boundary-layer approximation of the equations of motion, energy and concentration and associated free-surface boundary conditions. The heat/mass transport Péclet numbers are taken sufficiently large so that to take into account the convective terms of the heat/mass transport equations. Perticular emphasis is given to permanent-form traveling solitary waves. We show that the solitary waves can be dispersive and the size of dispersion depends on the size of the Prandtl and Schmidt numbers while its sign can change from positive to negative leading to negative-hump solitary waves. For large dispersion and for a sufficiently large region of Reynolds numbers, the liquid layer can be excited in the form of nondissipative solitary pulses which close to criticality assume the form of Kortweg-de Vries solitons.

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