Meeting: 1005, Newark, Delaware, SS 11A, Special Session on Recent Progress in Thin Fluid Flows

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Mathematical problems in electrified falling film problems.

A viscous liquid film falling under gravity on an inclined flat plane electrode is considered when a vertical electric field acts. The case of a perfect conducting fluid is considered first. The effect of the field is to cause additional stresses at the liquid air interface which can cause an instability at small but finite Reynolds numbers. We are concerned with the nonlinear spatio-temporal evolution of this problem. We derive a modified Kuramoto-Sivashinsky (KS) equation for the free surface with an additional non-local term due to the presence of the field. This term is linear and increases the instability causing a competition between fourth order diffusion and a third order growth in addition to the usual second order negative diffusion of the KS equation. We present numerical evidence indicating the global existence of solutions and a tendency towards more chaotic behavior for the modified equation. We also prove a global existence theorem and provide estimates for the L_2 norm of the solution as a function of the electric field parameter. Analyticity results are also discussed. (Received January 22, 2005)