Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

Electrostatic control of flows of moderate Reynolds number[1]
DEMETRIOS PAPAGEORGIOU, ALEX WRAY, OMAR MATAR, Imperial College London — Film flow down an inclined plane is a widely investigated problem because it serves as an important prototypical situation for analysis. Under the assumption that the characteristic wavelength of coherent structures is long relative to the thickness of the film, this system can be modelled to second order by the boundary-layer equations. However, the perturbative approach, which enslaves the system to the dynamics of the interface, typically results in equations (e.g. the Benney equation) that exhibit finite-time blow-up. It has been shown that a weighted-residual approach gives rise to simple equations which exhibit very good agreement with both direct numerical simulations and experiments in both the drag-gravity and drag-inertia regimes. We extend this system by allowing the plane to serve as an electrode, and incorporating a second parallel plane positioned above the fluid. The variation in the resultant electric fields in each region induces a Maxwell stress at the interface. We validate our model in one dimension via comparisons of linear theory, and by direct numerical simulations of both transient solutions and traveling waves. We then extend this to the two dimensional case to exhibit the degree of control afforded by the electric field.

[1]EPSRC DTG

Omar Matar
Imperial College London

Date submitted: 26 Jul 2013 Electronic form version 1.4