Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

Nonlinear interfacial dynamics in stratified multilayer channel flows[1] DEMETRIOS PAPAGEORGIOU, EVANGELOS PAPAEFTHYMIOU, GRIGORIOS PAVLIOTIS, Imperial College London, INTERFACIAL FLUID DYNAMICS COLLABORATION — Viscous immiscible pressure-driven multilayer flows in channels are investigated using a combination of modelling, analysis and computations. Three stratified layers with two internal interfaces are considered and long wave theory is used to derive a coupled system of Benney-type equations containing a small parameter that cannot be scaled out. A consistent system of coupled weakly nonlinear equations is developed and two canonical cases are identified in the absence and presence of inertia, respectively. The system supports instabilities not found in single long-wave equations including, transitional instabilities due to a change of type of the nonlinearities from hyperbolic to elliptic, kinematic resonance instabilities, and long-wave instabilities induced by an interaction between nonlinearity and surface tension. In contrast to two-layer systems instabilities leading to nonlinear traveling waves are possible even at zero Reynolds number. When inertia is present the systems become general coupled Kuramoto-Sivashinsky type equations. Numerical experiments produce dynamics including traveling, time-periodic traveling, and chaotic waves. It is also possible to regularise chaotic dynamics into traveling waves by enhancing the inertialess instabilities through the advective terms.

[1]National Science Foundation, Engineering and Physical Sciences Research Council (UK)

Demetrios Papageorgiou
Imperial College London

Date submitted: 02 Aug 2013 Electronic form version 1.4