Abstract Submitted
for the MAR08 Meeting of
The American Physical Society

A Possible Role for a Viscous Fingering-Type Instability in Cell Motility ANDREW CALLAN-JONES, JEAN-FRANCOIS JOANNY, Institut Curie-Phyiscal Chemistry Laboratory, JACQUES PROST, Institut Curie-Phyiscal Chemistry Laboratory/ESPCI — We present a novel flow instability that can arise in thin films of cytoskeletal fluids if the friction with the substrate on which the film lies is sufficiently strong. The motivation for this work are the experiments of Verkhovsky et al. (Verkhovsky et al, Curr. Biol., 9: 11-20 (1999)) in which flat, circular, stationary cell fragments on a substrate, containing only actin and myosin motors, can either spontaneously or under applied force change shape and start moving. In the stationary state in our model, actin polymerizes at the fragment edge and depolymerizes uniformly in the bulk. The initial velocity profile is radial and is imposed by mass conservation for constant polymer density. The radius of the fragment is fixed by conservation of total — monomer and filamentous—actin. Performing a linear stability analysis of the actin velocity due to perturbations of the fragment boundary, we find that as the dimensionless parameter $\frac{\eta}{\xi R_0^2} \to 0$, where ξ is the actin-substrate friction, η is the viscosity, and R_0 is the initial fragment radius, the perturbed velocity obeys a Darcy Law, and combined with the force-free condition at the fragment boundary, this leads identically to a viscous fingering instability. This asymptotic limit should be achievable since R_0 can be tuned by making a fragment with enough actin.

Andrew Callan-Jones
Institut Curie-Phyiscal Chemistry Laboratory

Date submitted: 05 Dec 2007 Electronic form version 1.4