

Abstract Submitted
for the MAR08 Meeting of
The American Physical Society

The Stochastic Dynamics of Filopodial Growth¹ GAREGIN A. PAPOIAN, YUEHENG LAN, PAVEL ZHURAVLEV, The University of North Carolina at Chapel Hill — A filopodium is a cytoplasmic projection, exquisitely built and regulated, which extends from the leading edge of the migrating cell, exploring the cell's neighborhood. Commonly, filopodia grow and retract after their initiation, exhibiting rich dynamical behaviors. We model the growth of a filopodium based on a stochastic description which incorporates mechanical, physical and biochemical components. Our model provides a full stochastic treatment of the actin monomer diffusion and polymerization of each individual actin filament under stress of the fluctuating membrane. We have investigated the length distribution of individual filaments in a growing filopodium and studied how it depends on various physical parameters. The distribution of filament lengths turned out to be narrow, which we explained by the negative feedback created by the membrane load and monomeric G-actin gradient. We also discovered that filopodial growth is strongly diminished upon increasing retrograde flow, suggesting that regulating the retrograde flow rate would be a highly efficient way to control filopodial extension dynamics. The filopodial length increases as the membrane fluctuations decrease, which we attributed to the unequal loading of the membrane force among individual filaments, which, in turn, results in larger average polymerization rates. We also observed significant diffusional noise of G-actin monomers, which leads to smaller G-actin flux along the filopodial tube compared with the prediction using the diffusion equation.

¹This work was supported through National Science Foundation (NSF) grant 0715225.

Garegin A. Papoian
The University of North Carolina at Chapel Hill

Date submitted: 27 Dec 2007

Electronic form version 1.4