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Single Actin Filaments Pushing Loads: Growth Kinetics and Fluctuations BEN O'SHAUGHNESSY, Chemical Engineering, Columbia Univ, DIMITRIOS VAVYLONIS, Chemical Engineering, Columbia Univ and Molecular, Cellular and Developmental Biology, Yale Univ — Many types of cellular motions are driven by the polymerization and depolymerization of actin filaments growing or shrinking against cellular loads. Actin growth involves polymerization of ATP-actin monomers followed by fast ATP hydrolysis and slow phosphate release generating unstable ADP-actin. We present Monte Carlo simulations and analytical theory describing growth kinetics of single filaments pushing against external loads. Our work is related to earlier work by Mogilner and Oster (*Biophys.J.* **71**, 3030, 1996). We find the behavior near stall is influenced by (1) hydrolysis and phosphate release and (2) fluctuations in growth rates. Fluctuations become important near stall conditions, where growth rate vanishes. We find that under zero external load actin filaments have a long fluctuation-stabilized ATP/ADP-Pi cap at the critical concentration (the corresponding stall situation) whose origin is the slow rate of Pi release. As a result, filament growth rate exhibits a smoothed slope discontinuity. Fluctuations, described by the length diffusivity, exhibit a pronounced smoothed discontinuity in magnitude whose origin is uncapping events exposing rapidly depolymerizing ADP-actin. The presence of external loads perturbs the polymerization rate constants, leading to modified kinetics which depend on filament length and imposed force-distance profile.

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