Spontaneous Actin Dynamics: Unimodal Length Distributions and Polymerization Waves

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Abstract:

Actin is one of the most abundant proteins in animal cells. It can aggregate into filaments which form a tight mesh underneath the plasma membrane of many eukaryotic cells. This network has a strong impact on the mechanical properties of the cells, forms important cellular structures, and drives a number of vital processes. Obviously, these tasks cannot be achieved by a system at thermodynamic equilibrium and indeed ATP hydrolysis intrinsically drives the assembly of actin filaments as well as the generation of stresses in the actin network and many molecules are known today that regulate the dynamics of the actin gel. How the actin network is organized on supramolecular scales to perform the various tasks mentioned above is, however, largely unknown. Evidence has accumulated that spontaneous processes might play a central role in this context. This will be illustrated with two examples. First of all, I will discuss the length dynamics of actin filaments and show that treadmilling, a state during which filaments grow at one and shrink at the other end, goes hand in hand with unimodal length distributions, which are unknown to equilibrium polymer systems. Secondly, I will present possible mechanisms for the generation of spontaneous polymerization waves and discuss their potential role for cell locomotion and cell behavior.

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