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Cell Motility Resulting form Spontaneous Polymerization Waves[1]

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The crawling of living cells on solid substrates is often driven by the actin cytoskeleton, a network of structurally polar filamentous proteins that is intrinsically driven by the hydrolysis of ATP. How cells organize their actin network during crawling is still poorly understood. A possible general mechanism underlying actin organization has been offered by the observation of spontaneous actin polymerization waves in various different cell types. We use a theoretical approach to investigate the possible role of spontaneous actin waves on cell crawling. To this end, we develop a meanfield framework for studying spatiotemporal aspects of actin assembly dynamics, which helped to identify possible origins of self-organized actin waves. The impact of these waves on cell crawling is then investigated by using a phase-field approach to confine the actin network to a cellular domain. We find that spontaneous actin waves can lead to directional or amoeboidal crawling. In the latter case, the cell performs a random walk. Within our deterministic framework, this behavior is due to complex spiral waves inside the cell. Finally, we compare the seemingly random motion of our model cells to the dynamics of cells of the human immune system. These cells patrol the body in search for infected cells and we discuss possible implications of our theory for the search process' efficiency.

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