The motile machinery of amoeboid cells operates at the edge of oscillations

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The rapid reorganization of the actin cytoskeleton in response to external stimuli is an essential property of many motile eukaryotic cells. Here, we report evidence that the actin machinery of chemotactic *Dictyostelium* cells operates close to an oscillatory instability. When averaging the actin response of many cells to a short pulse of the chemoattractant cAMP, we observed a transient accumulation of cortical actin reminiscent of a damped oscillation. At the single-cell level, however, the response dynamics ranged from short, strongly damped responses to slowly decaying, weakly damped oscillations. In a small subpopulation, even self-sustained oscillations in the cortical F-actin concentration were observed. To substantiate that an oscillatory mechanism governs the actin dynamics in these cells, we systematically exposed a large number of cells to periodic pulse trains of different frequencies (periodic forcing). We found a clear resonance peak at a stimulation period of around 20 s. To explains our experimental findings, we introduced a delayed feedback model that is based on a time-delay in the regulatory network of the actin system. Additional experiments with cells lines that carry mutations in regulatory proteins of the cytoskeleton confirm our model and allow us to independently estimate the delay time in the regulatory feedback loop.

1. C. Westendorf, J. Negrete Jr., A.J. Bae, R. Sandmann, E. Bodenschatz, and C. Beta, PNAS, **110**, 3853-3858 (2013).