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Protrusion phenotypes driven by actin-membrane interaction

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We present a mathematical model for the leading edge motion of migrating cells. A variety of dynamic regimes is observed experimentally, e.g. uniform oscillations and local protrusions or undulations traveling along the plasma membrane. Our model reproduces those states of movement. We calculate the force that single actin filaments of different contour length in the lamellipodium exert on the membrane. The total actin network force is not only length dependent but also determined by the attachment dynamics of the filaments. The membrane motion then results from the balance of this actin network force, viscous drag force and membrane tension in every point along the membrane. A change in model parameters like the polymerization velocity of actin filaments can lead to a change in the dynamic state of membrane motion. Accordingly, in experiments with epithelial cells, different morphodynamic patterns are observed under wild type conditions and in cells expressing constitutively active Rac.