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Models of Moving Cell Morphologies

Cell migration is a pervasive process in many biology systems and involves protrusive forces generated by actin polymerization, myosin dependent contractile forces, and force transmission between the cell and the substrate through adhesion sites. Here we develop a computational model for cell motion that uses the phase field method to solve for the moving boundary with physical membrane properties. It includes a reaction-diffusion model for the actin-myosin machinery and discrete adhesion sites which can be in a "gripping" or "slipping" mode and integrates the adhesion dynamics with the dynamics of the actin filaments, modeled as a viscous network. To test this model, we apply it to fish keratocytes, fast moving cells that maintain their morphology, and show that we are able to reproduce recent experimental results on actin flow and stress patterns. Furthermore, we explore the phase diagram of cell motility by varying myosin II activity and adhesion strength. Future work will focus on extending this model to encompass the pseudopod-dominated motility seen in Dictysotelium amoebae and in human neutrophils.