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Coupling actin flow, adhesion, and morphology in a computational cell motility model

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Eukaryotic cells crawl by means of the coordinated spatiotemporal dynamics of an active polymer gel, consisting of actin, myosin and regulators thereof. Motility is necessarily coupled to shape, as the force generating mechanisms such as polymerization-based protrusions interact with the elasticity of the cell membrane and thereby determine the cell morphology. We have introduced a "phase-field" model of crawling cells, utilizing a mathematical approach originally developed for morphology problems arising in the field of liquid-solid phase transitions. Our model can be used to explain the pattern of traction forces applied to the substrate as well as some recent observations concerning oscillatory instabilities of cells moving on one-dimensional fiber tracks.