Coordination of Contraction, Flow, and Adhesion in Migration of Physarum Plasmodia

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Recent evidence has shown that the fluid dynamics of cytoplasm can play a vital role in cellular motility. The true slime mold *Physarum polycephalum* provides an excellent model organism for the study of fluid driven cell locomotion, as it exhibits a vast array of sophisticated manipulations of its intracellular cytoplasm. Growing microplasmodia of *Physarum* have been observed to adopt an elongated tadpole shape, then contract in a rhythmic, traveling wave pattern that resembles peristaltic pumping. This contraction drives a fast flow of non-gelated cytoplasm along the cell longitudinal axis. It has been hypothesized that this flow of cytoplasm is a driving factor in generating motility of the plasmodium, but how does an organism drive locomotion using peristalsis? In this work, we use several mathematical models to investigate how peristaltic pumping as seen in *Physarum* may be used to drive cellular motility. Computations are carried out using a generalization of the Immersed Boundary Method (IBM) adapted to simulate poro-elastic materials. We investigate the relationship between mechanical properties of the cell, contractile stresses within the cell, flow of cytoplasmic fluid, and adhesion to the underlying substrate. These quantities exhibit wave-like patterns, who's magnitude and relative phases are compared to experimental values in an attempt to characterize conditions necessary to generate directed motion.