An active rigidity percolation transition in the actomyosin cortex drives a minimal morphogenetic and motile machinery

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Most metazoan cells can display a spontaneous motile behavior. This locomotion capacity of single cells is generally attributed to the fundamental properties of the actomyosin network which can polarize and produce directed forces. Experimental as well as theoretical work have converged to define the general properties of actomyosin systems. Nevertheless, there has been so far no time-resolved description of actomyosin networks dynamics down to the single filament in live motile cells. Here, we combine confinement to induce the formation of stable blebs - motile structures with a simple shape - with high numerical aperture total internal reflection fluorescence microscopy, to investigate the assembly of the flowing actin cortex from single actin filaments. Our study points to the importance of the active advection, powered by rear located myosin motors, of a rigid, passive solid-like state of the actin cortex. We propose a physical model that shows how a self-organized spatial patterning of the actin filaments network emerges due to the active advection by motors, combined with a rigidity percolation transition. This spatial organization gives stability and mechanical properties (soft front and solid back) to the network and constitute a minimal locomotion mechanism that can produce robust and fast migration through complex environments.