

A mechanism for contraction of cytokinetic actin rings

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In the late stages of cell division, animal cells are cleaved by contraction of the cytokinetic ring. The ring consists of actin filaments, molecular motors, and other proteins. How this ring generates an average net contractile stress is still poorly understood.

Here, we study a mechanism involving the formation of bipolar filaments by joining polar actin filaments of opposite orientation at their barbed ends. We develop a continuum mean-field model for the dynamics of actin filaments and motors. A linear stability analysis shows that the homogenous distribution becomes unstable beyond a critical motor strength. Numerical solutions of the full dynamic equations exhibit a backward-bifurcating non-homogenous state with clustered filaments at distinct positions along the ring.

For sufficiently stable bipolar filaments, the distribution is stationary and reminiscent of muscle sarcomeres. In this state, the total stress is higher than in the homogenous state for the same parameters. If the bipolar filaments split fast enough into their polar constituting filaments, oscillatory states can be observed.

We discuss these findings in terms of recent experiments.