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Internal Webinar

Shape Transitions in a Network Model of Active Elastic Shells

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Morphogenesis involves the transformation of initially simple shapes, such as multicellular spheroids, into more complex 3D shapes. These shape changes are governed by mechanical forces including molecular motor-generated forces as well as hydrostatic fluid pressure, both of which are actively regulated in living matter through mechano-chemical feedback. Inspired by autonomous, biophysical shape change, such as occurring in the model organism hydra, we introduce a minimal, active, elastic model featuring a network of springs in a globe-like spherical shell geometry. In this model there is coupling between activity and the shape of the shell: if the local curvature of afilament represented by a spring falls below a critical value, its elastic constant is actively changed. This results in deformation of the springs that changes the shape of the shell. By combining excitation of springs and pressure regulation, we show that the shell undergoes a transition from spheroidal to either elongated ellipsoidal or a different spheroidal shape, depending on pressure. There exists a critical pressure at which there is an abrupt change from ellipsoids to spheroids, showing that pressure is potentially a sensitive switch for material shape. We thus offer biologically inspired design principles for autonomous shape transitions in active elastic shells.

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