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Stress activated contractile wavefronts in the mechanically-excitable embryonic heart KEVIN CHIOU, STEPHANIE MAJKUT, University of Pennsylvania, Department of Physics and Astronomy, DENNIS DISCHER, University of Pennsylvania, Department of Chemical and Biomolecular Engineering, TOM LUBENSKY, ANDREA LIU, University of Pennsylvania, Department of Physics and Astronomy — The heart is a prime example of a robust, active system with behavior–the heart beat–that is extraordinarily well timed and coordinated. For more than half a century, electrical activity induced by ion release and diffusion has been argued to be the mechanism driving cardiac action. But recent work indicates that this phenomenon is also regulated by mechanical activity. In the embryonic avian heart tube, the speed of the contractile wavefront traversing the heart tube with each beat is measured to be a monotonic, linear function of tissue stiffness. Traditional electrical conduction models of excitation-contraction cannot explain this dependence; such a result indicates that the myocardium is mechanically excitable. Here, we extend this work by using experimental observations of stiffness-dependent behavior in isolated cardiomyocytes as an input to study contractile wavefronts in the tissue as a whole. We model the heart tube as an active, overdamped elastic network where the primary stress mediator is the extracellular matrix. Using this simple model, we explain experimental observations of the systolic wave and predict qualitatively new behavior.

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