Stress-Driven Anisotropic Diffusion in Active Deformable Media

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Abstract

Excitable media represent complex nonlinear electrochemical systems naturally coupled to several multiphysical factors. A remarkable example is the heart, which exhibits the propagation of nonlinear bioelectrical waves on a complex anatomical background undergoing large mechanical deformations [1]. Using a generalized theoretical framework, we extend a well-established mathematical model for reaction-diffusion-mechanics [2] by coupling directly the diffusion tensor to mechanical stress. We show that an initially isotropic and homogeneous diffusion tensor eventually becomes inhomogeneous and anisotropic. This phenomenon has been observed in the particular context of cardiac electromechanics during ventricular loading showing a clear relationship between variations in conduction velocity and strain anisotropy [3]. We study the physics underpinning such a nonlinear coupling and the conditions for its existence. Via a mixed-primal finite element method [4], we observe relevant consequences on anisotropy, drifting and computed conduction velocity of the excitation wave.

References

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