NEGATIVE FILAMENT TENSION IN LUO-RUDY MODEL OF CARDIAC TISSUE

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Rotation of a scroll ring is non-stationary: its filament drifts in space. Two main drift regimes are: filament contraction (positive tension) and filament expansion (negative tension) [1].
Negative filament tension may result in instability that was studied for linear filaments and scroll rings in simplified models of excitable medium [2,3].
Aim of this study is to find if the negative filament tension and instabilities are possible in an ionic model of cardiac tissue.
We use an Luo-Rudy phase 1 model:

$$\frac{\partial V}{\partial t} = -I_{ion} + D\Delta V$$

Here V is the transmembrane potential, t is time, D is the diffusion coefficient and I_{ion} is the sum of all transmembrane ionic currents.
For I_{ion} we use: $I_{ion} = I_{Na} + I_{si} + I_K + I_{K1} + I_{Kp} + I_b$ and the corresponding equations for gating variables as described in [4].
Parameter settings are as in the original model except for the I_{si}, I_{Na} conductances.
As we can see in the figure negative filament tension exists in the Luo-Rudy phase 1 model for parameter values corresponding to a low excitable cardiac tissue. Negative filament tension can induce electrical turbulence in a homogeneous slab of cardiac tissue.

[1] A. V. Panfilov and A. N. Rudenko, Physica D **28**, 215 (1987).

[2] V. N. Bikthasev, A. V. Holden and H. Zhang, Phil. Trans. R. Soc. Lond. A **347**, 611 (1994).

[3] S. Alonso, F. Sagués and A. S. Mikhailov, Science **299**, 1722 (2003).

[4] C. Luo and Y. Rudy, Circ. Res. **68**, 1501 (1991).