Vortex dynamics in reaction-diffusion equations with applications to electrophysiology

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I will present a short overview of three main directions of our research:

(1) Analytical and numerical studies of vortex filament dynamics in reaction-diffusion equations. Two topics to be discussed here are: filament dynamics in equal diffusion case and its relation to 3D vortices in BZ reaction; prediction of stable filament shapes in RD equations with anisotropic diffusion.

(2) Development of virtual human heart model. Here I will report on the development of an anatomically accurate model for the human heart based on anatomical data set by R. Hren and our equations for human cardiac cells. I will present results of our studies of 3D organization of ventricular fibrillation in human heart, and compare our conclusions to the available experimental and clinical data.

(3) Spiral waves and Turing structures in reaction-diffusion equations, coupled with equations of finite elasticity. Here I will briefly report on our approach for studies of reaction-diffusion-mechanics system and present our preliminary results on the onset of the pacemekers induced by deformation, onset of spatio-temporal chaos and onset of dynamical attractors for spiral waves due to the mechanics-reaction-diffusion feedback. Possible application of this approach for Turing patterns formation will be also discussed.