

Workshops on Computational Modeling of Complex Systems

Nancy Griffeth and Flavio Fenton

Nov 21, 2013

2013 NSF-CMACS Workshop on Atrial Fibrillation

January 7, 2013 - January 25, 2013

from 10 am to 4 pm, Monday to Friday



Workshop Objectives

- Disseminate project work among promising students
- Encourage enthusiasm for research and modeling complex systems
- Find good prospects for REU and graduate programs
- Encourage under-represented minorities to enter STEM fields
- Encourage inter-disciplinary work
- Develop course materials

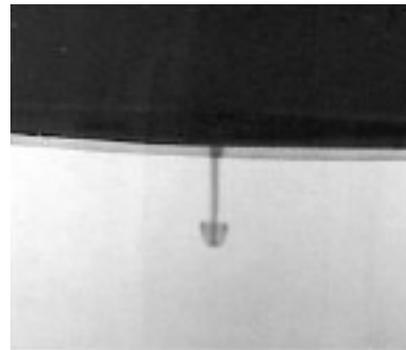
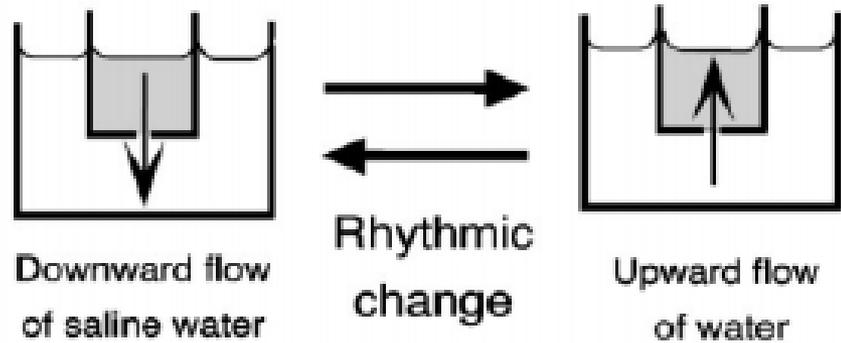
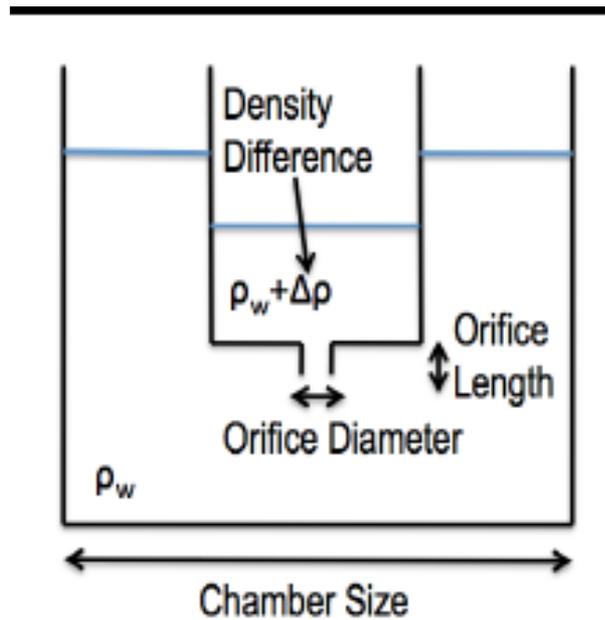
- Lectures by Nancy Griffeth and Flavio Fenton
- Guest lectures (Robert Gilmour, Bard Ermentrout and Elizabeth Cherry)
- Labs with hands on experiments
- Computer labs with exercises in Java and WebGL.
- Final project using GPU computing.

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Lectures

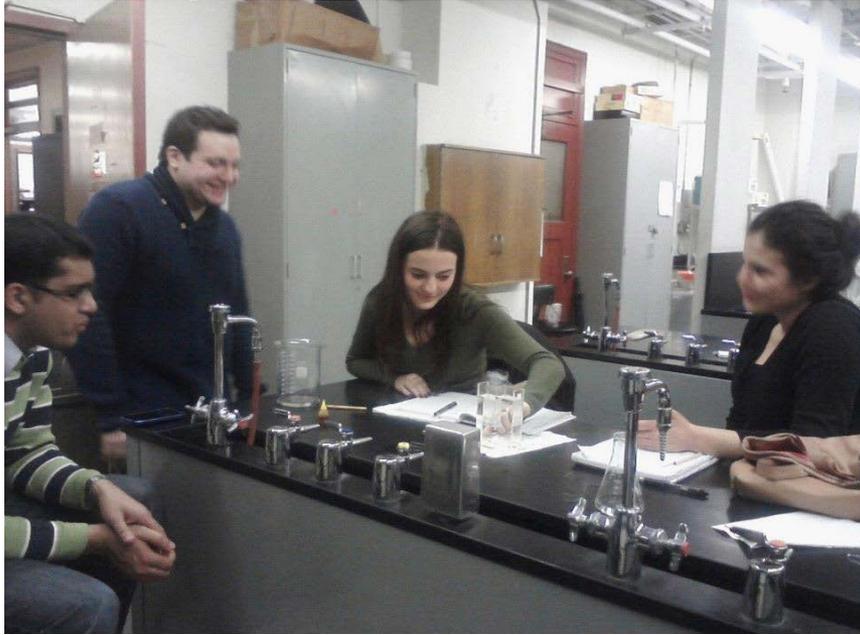


Saline oscillator



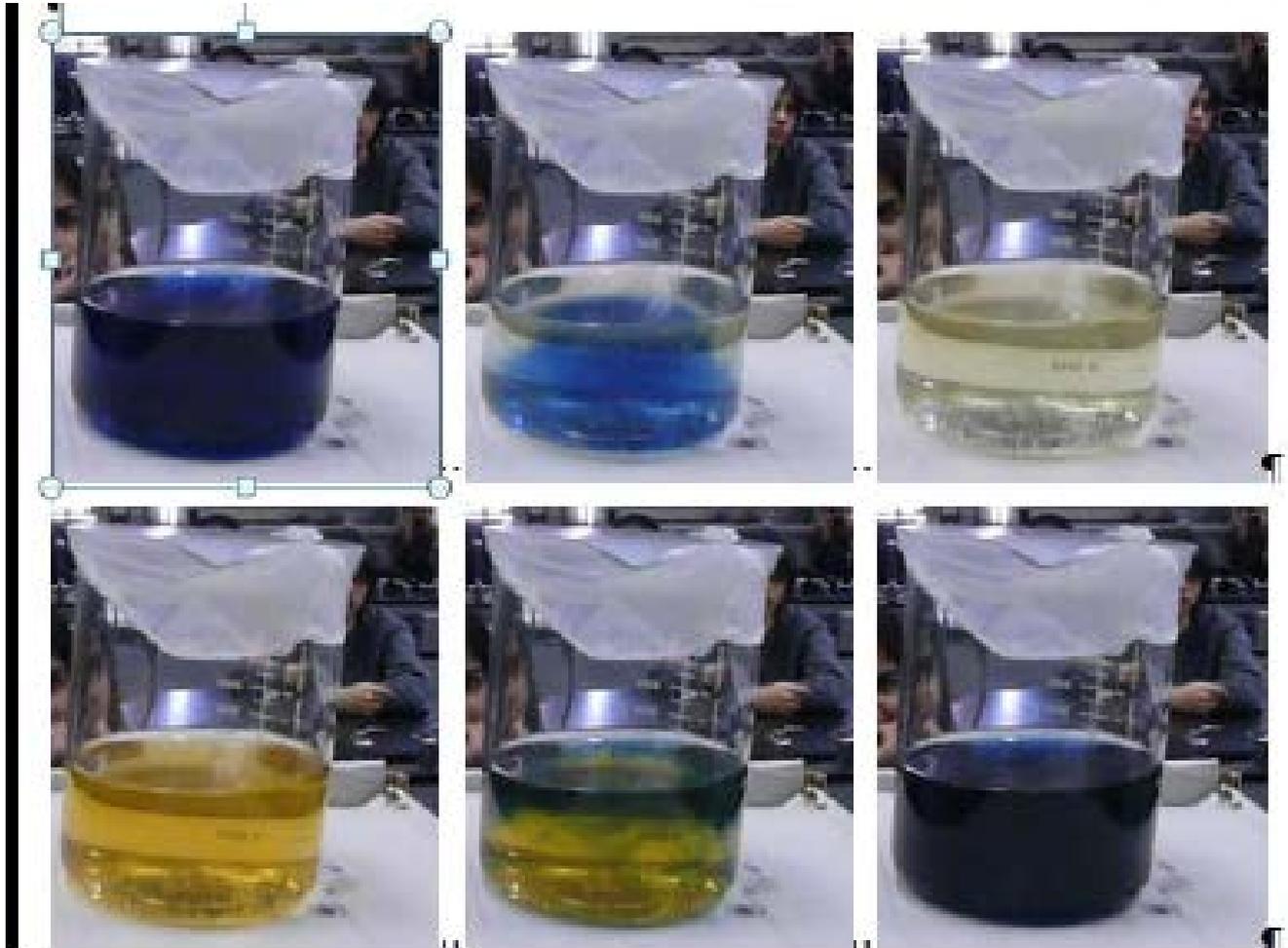
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Saline oscillator



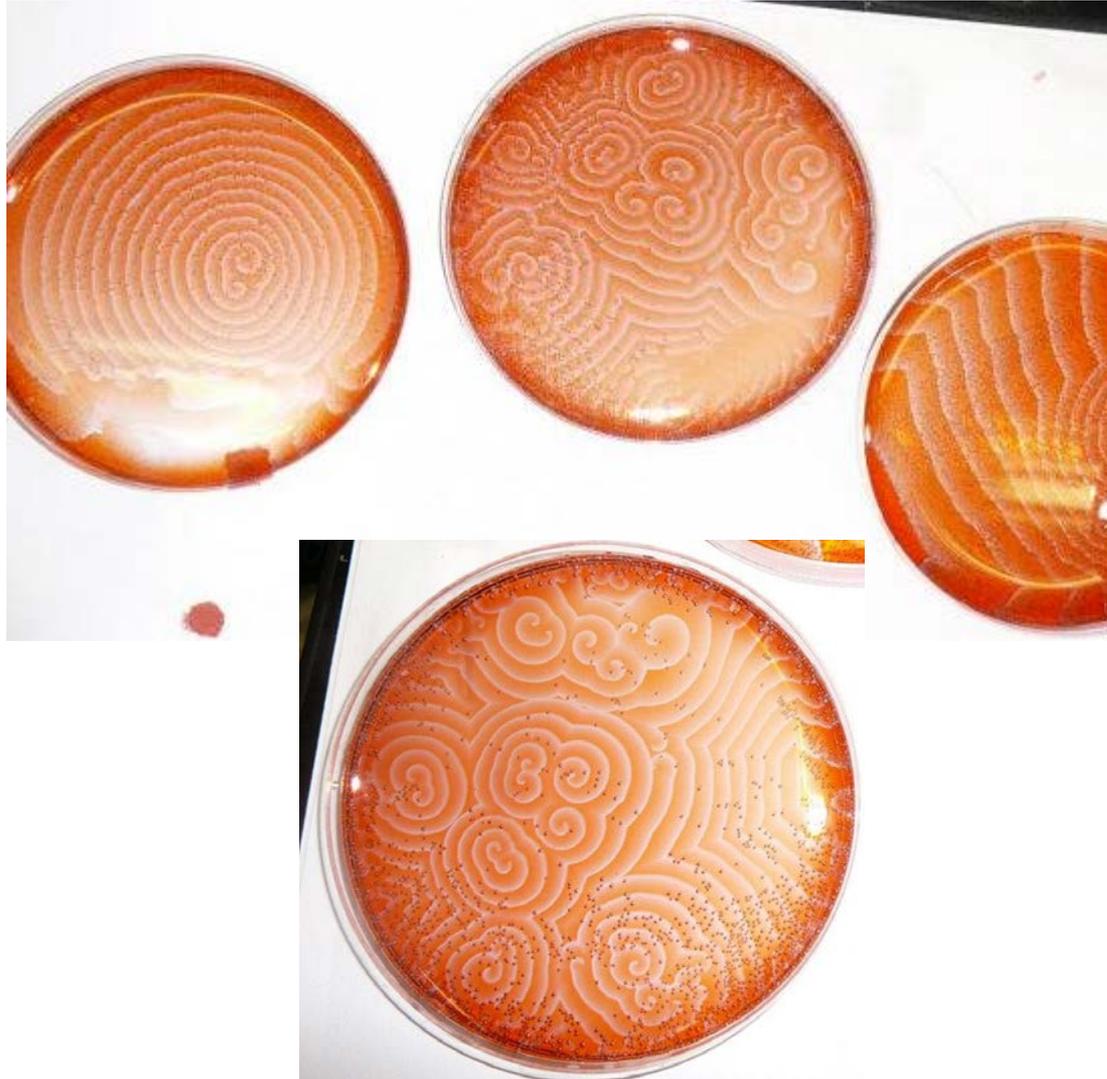
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Chemical Oscillator



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Chemical Oscillator



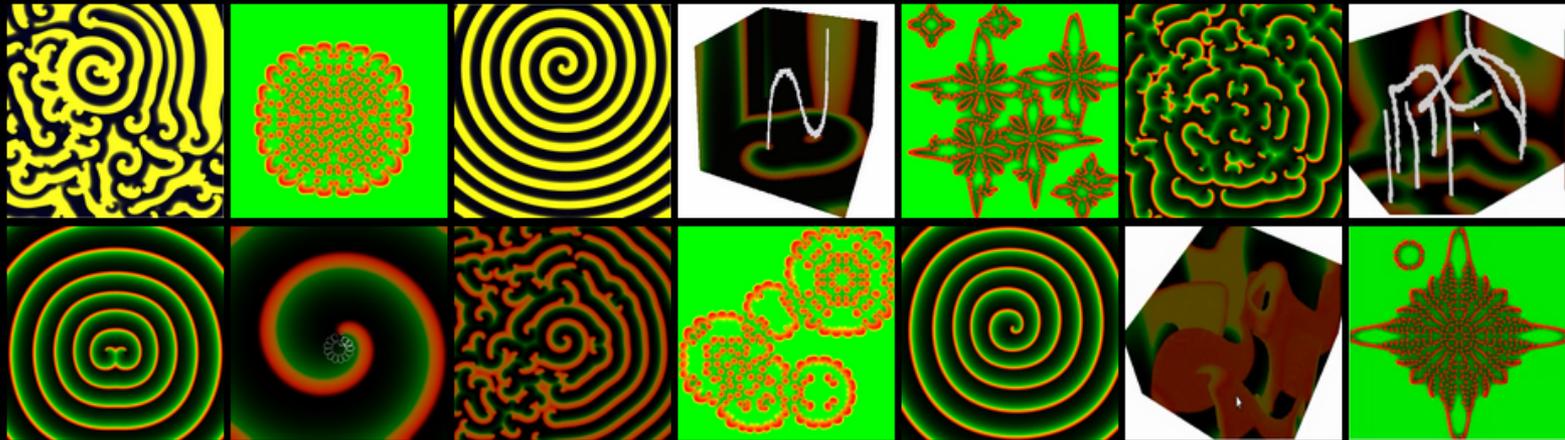
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Chemical Oscillator



thevirtualheart.org/webgl/DS_SIAM/SIAM_webgl_pattern_formation.html samson and delilah

Emerging Behavior and Spatiotemporal Chaos in Reaction-Diffusion Models: GPU-accelerated simulations in a web browser over the internet.



We present here a set of interactive programs to study and analyze several models of excitable media in tissue. As the waves they produce propagate through the media, the models exhibit complex spatiotemporal dynamics that cannot be appreciated from an analysis of the underlying equations or even verbal descriptions. Here, we allow users to perform in real time simulations of these models and to watch the patterns develop and change over time as the simulated dynamical waves propagate. The parameters governing the model's behavior can be changed on the fly to alter the dynamics. In addition, users can apply perturbations and periodic pacing, that change the patterns locally and globally and watch the response.

One of the main advantages of these programs is that the models are implemented using WebGL, which allows the simulations to be run over the Internet, independent of computer architecture and operating system. WebGL utilizes available hardware, including graphics cards, to improve

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Real time numerical simulations



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Lunches with students



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Final Projects

- Last workshop:

■ Last workshop:

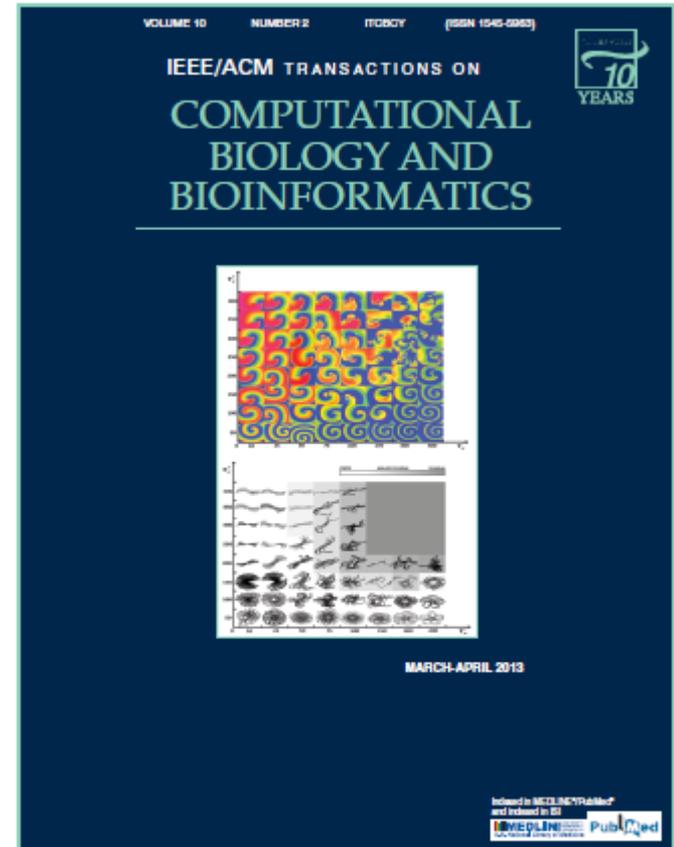
Teaching cardiac electrophysiology modeling to undergraduate students:
laboratory exercises and GPU programming for the study of arrhythmias
and spiral wave dynamics

Enzo Bartocci,¹ Rupinder Singh,² Frederick B. von Stein,³ Avesta Amedome,⁴ Alan Joseph J. Caceres,⁴
Juan Castillo,⁴ Evan Closser,² Gabriel Daards,⁴ Andriy Goltsev,⁴ Rounwelle Sta. Ines,⁴ Cem Isbillir,⁴
Joan K. Marc,⁴ Diquan Moore,⁴ Dana Pardi,⁴ Sandeep Sadhu,⁴ Samuel Sanchez,⁴ Pooja Sharma,⁴
Anoop Singh,⁴ Joshua Rogers,⁴ Aron Wolinetz,⁴ Terri Grosso-Applewhite,⁴ Kai Zhao,⁴
Andrew B. Filipski,⁵ Robert F. Gilmour, Jr.,² Radu Grosu,⁶ James Glimm,¹ Scott A. Smolka,⁶
Elizabeth M. Cherry,^{3,7} Edmund M. Clarke,⁸ Nancy Griffiths,⁴ and Flavio H. Fenton³

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⁵Department of Software Engineering, Rochester Institute of Technology, Rochester; ⁶Department of Computer Science, Stony Brook University, Stony Brook; ⁷School of Mathematical Sciences, Rochester Institute of Technology, Rochester, New York;

and ⁸Computer Science Department, Carnegie Mellon University, Pittsburgh, Pennsylvania

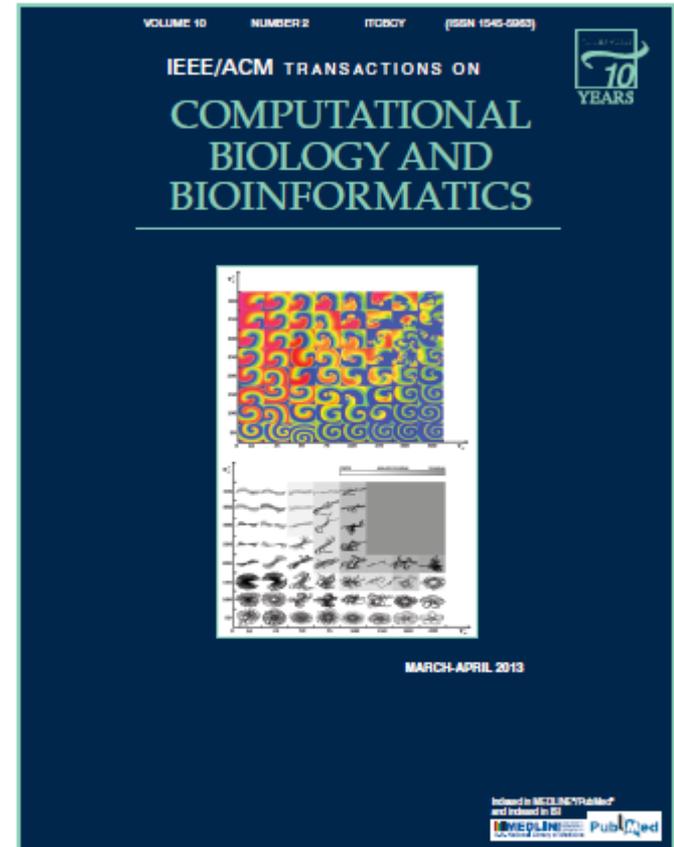


■ This workshop:

2013 Workshop: Student Exercises and Projects

Final Presentations

- » Group 1: [G_CaL versus G_Na](#)
- » Group 2: [G_CaL versus G_K1](#)
- » Group 3: [G_CaL versus G_Ks](#)
- » Group 4: [G_Na versus G_K1](#)
- » Group 5: [G_Na versus G_Ks](#)
- » Group 6: [G_Na versus k_NaCa](#)
- » Group 7: [G_CaL versus k_NaCa](#)



Project: to perform a similar study on a realistic complex ionic cell model:
The TNNP model for human ventricular cardiac cells.

Nancy Griffeth

Guest lecturers:

- Robert Gilmour
- Bard Ermentrout
- Elizabeth Cherry

Grad students:

- Aron Wolinetz
- Charles Beard
- Rachel Spratt
- Fred Von Stein