LIVING STATE PHYSICS
DEPARTMENT OF PHYSICS & ASTRONOMY, VANDERBILT UNIVERSITY

High Speed Fluorescence Imaging of Cardiac Action Potentials: Confirmation of the Doubly Anisotropic Bidomain Model

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Cardiac Electrodynamics: Just how does your heart work, and not?

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The Heart is a…

- Biochemically powered,
- Electrically activated,
- Pressure- and volume-regulated,
- Two-stage,
- Tandem,
- Mechanical pump
- With a mean time-to-failure of approximately two billion cycles.

Outline

- A brief review of cardiac physiology
- The classical forward and inverse problems
- The ultimate forward and inverse problems
- Questions, questions, questions ...

Cardiac Spatial Scales

The spatial scales that govern cardiac electrodynamics range from the ten-centimeter diameter of the entire heart, to the nanometer pore of the gated ion channels, to the sequence of the proteins that form those channels

Cardiac Temporal Scales

The time scales of cardiac electrodynamics range from the one-second heart beat and the many seconds of a complex arrhythmia to the nanosecond conformational changes of protein channels.

The Challenge

The experimental and theoretical challenge offered by studies of cardiac fibrillation arises from the fact that cardiac electrical activity fully spans both scales: a factor of 10^9 in time and 10^{24} in volume.

Symmetry, Silent Sources, and Magnetic Imaging with SQUIDs

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