Abstract View

A HYBRID ELECTRO-DIFFUSION MODEL FOR NEURAL SIGNALING.

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A new method is introduced for modeling the three-dimensional movement of ions in neurons. Using the Nernst-Planck equation, concentration gradients and electric fields were evaluated using a weighted moving least-squares algorithm. We incorporate this method into MCell, a Monte-Carlo cell simulator, and present preliminary validation under several testing scenarios. We apply the method to a reactive-diffusive simulation of an action potential propagating through an unmyelinated axon, with discrete sodium and potassium channels modeled by a voltage-dependent Markov random process. For large diameter axons, the spatio-temporal dynamics of the membrane potential averaged over several runs converges to results obtained from the Hodgkin and Huxley model implemented in NEURON. The results also corroborate previous stochastic simulations by other workers demonstrating that at thin diameters channel noise is sufficient to induce action potentials*.

*SB Laughlin, private communication.

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