Two Partitioned Numerical Methods for Solving the Hodgkin-Huxley Equations

Zhengdao Chen

Washington University in St. Louis

Follow this and additional works at: https://openscholarship.wustl.edu/wushta_spr2017

Recommended Citation
https://openscholarship.wustl.edu/wushta_spr2017/15

This Abstract for College of Arts & Sciences is brought to you for free and open access by the Washington University Senior Honors Thesis Abstracts at Washington University Open Scholarship. It has been accepted for inclusion in Spring 2017 by an authorized administrator of Washington University Open Scholarship. For more information, please contact digital@wumail.wustl.edu.
The Hodgkin-Huxley model, a system of four-dimensional ordinary differential equations, is a fundamental mathematical model of the dynamics of a neuron’s membrane voltage. Simulating neurons’ activities using the Hodgkin-Huxley equations is computationally expensive compared to using some other neuronal models, and there have been interests in looking for efficient numerical methods for solving the Hodgkin-Huxley equations. We aimed at looking for numerical methods that can solve the Hodgkin-Huxley equations with high stability, and studied two partitioned methods in particular. First, we adapted the Störmer/Verlet method for Hamiltonian systems to the Hodgkin-Huxley equations, resulting in a method coinciding with a modified version of the trapezoidal method. Second, we created a type of Strang splitting method. In numerical experiments, we found that the Störmer/Verlet method has higher stability than Euler’s method and the Fourth Order Runge-Kutta method, two commonly used numerical methods, and that the Strang splitting method has even higher stability than the Störmer/Verlet method. Theoretically, both the Störmer/Verlet method and the Strang splitting method can be shown to have second order convergence. Furthermore, when applied to solve the van der Pol equations, a simpler nonlinear dynamical system chosen for theoretical analysis, both of these methods can be shown theoretically to preserve the size of the limit cycle to the second order because of their symplecticity.