

Step Current Response of the HH Model

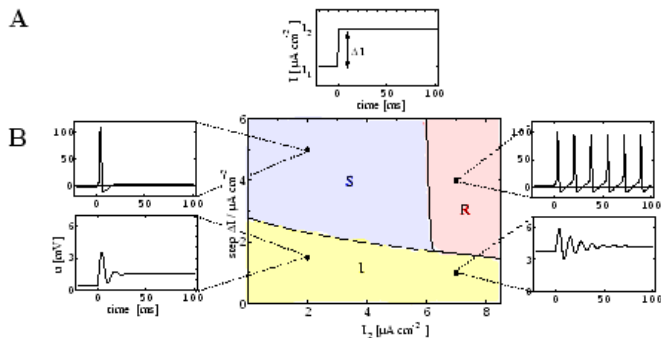
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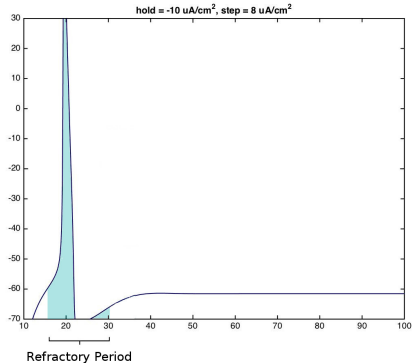
December 4, 2014

HH Model Step Current Response



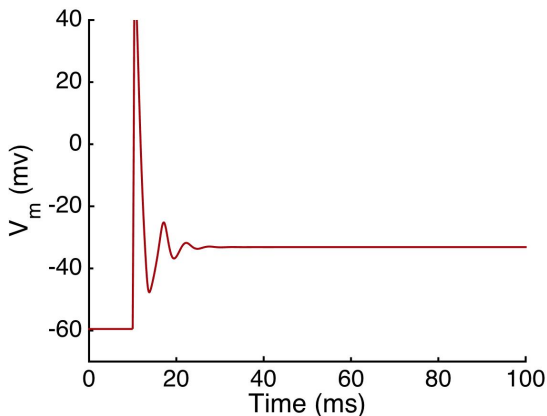
Step Current Stimulation Phase diagram

Applications: Refractory Period



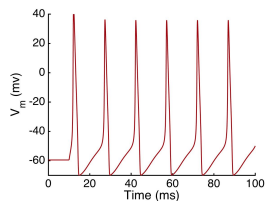
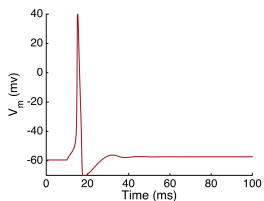
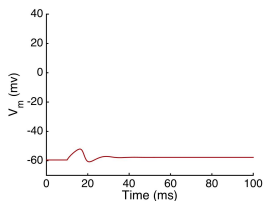
Reducing the Refractory Period can lead to faster reflexes.

Applications: Neuron Inhibition



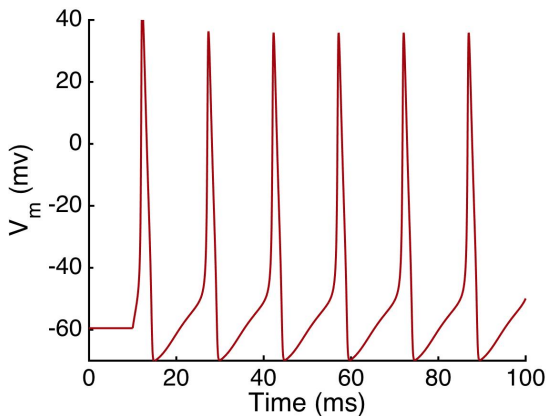
High current fully damps neuron response

Simulation Response Regions



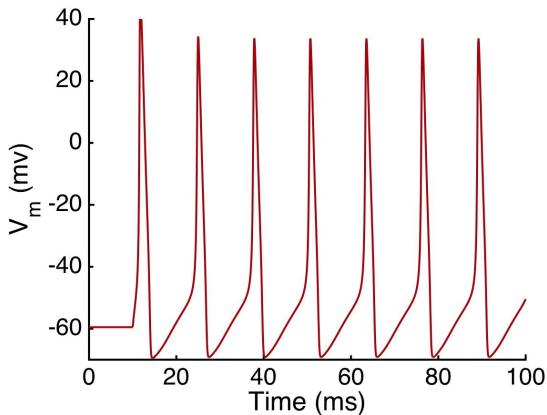
Response in the *Ringing*, *Single AP* and *AP Train* regions

HH Model Action Train



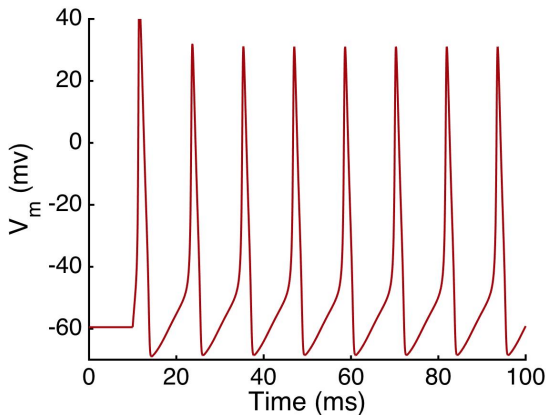
Stepping to $10 \mu A/cm^2$

HH Model Action Train

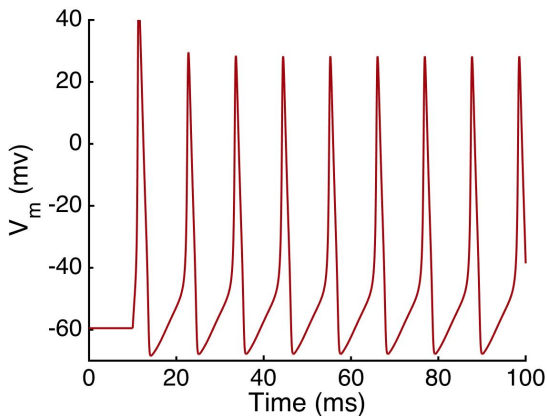


Stepping to $15 \mu A/cm^2$

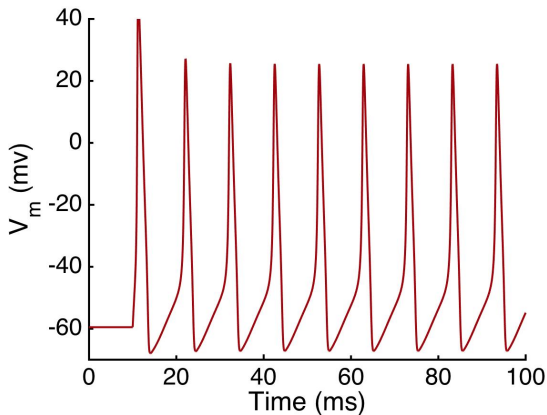
HH Model Action Train



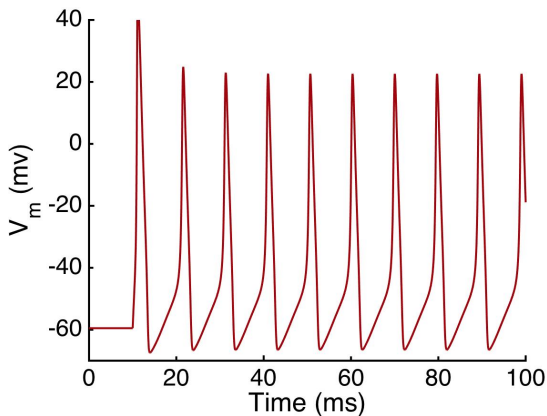
HH Model Action Train



HH Model Action Train

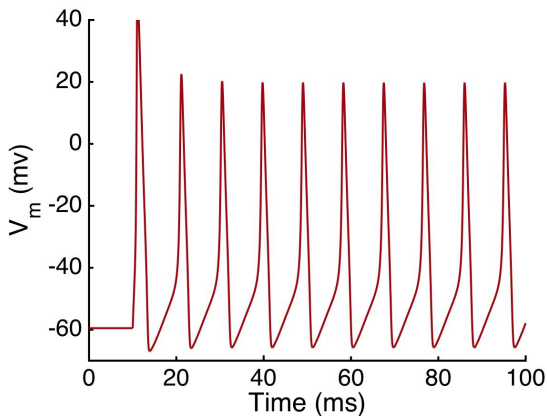


HH Model Action Train

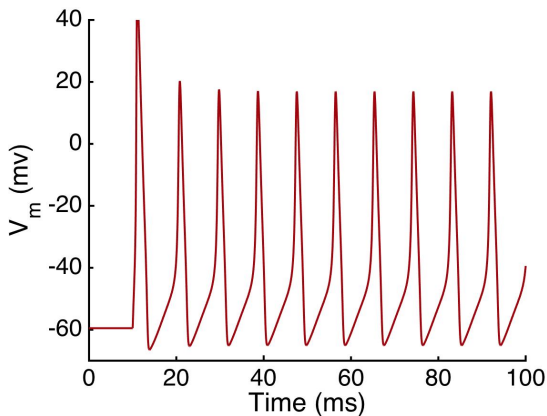


Stepping to $35 \mu A/cm^2$

HH Model Action Train

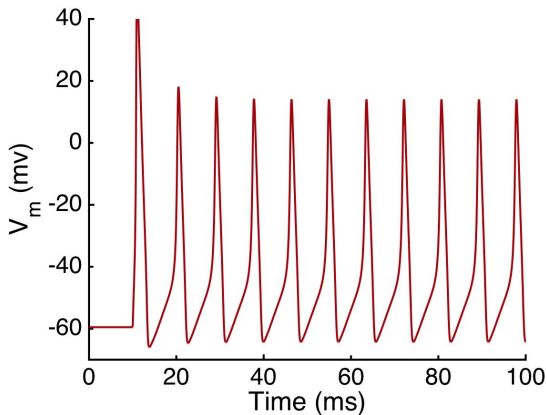


HH Model Action Train



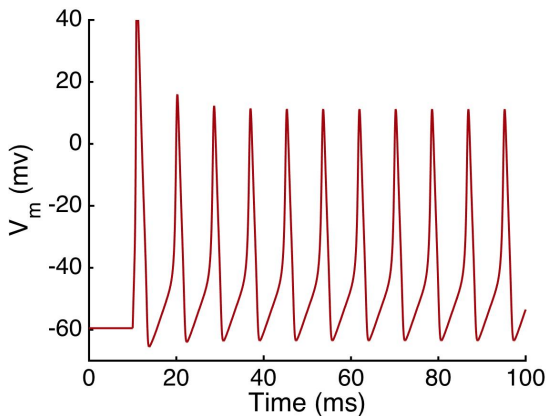
Stepping to 45 $\mu A/cm^2$

HH Model Action Train

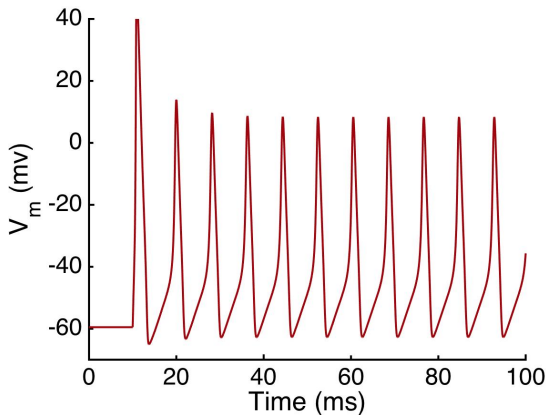


Stepping to $50 \mu A/cm^2$

HH Model Action Train

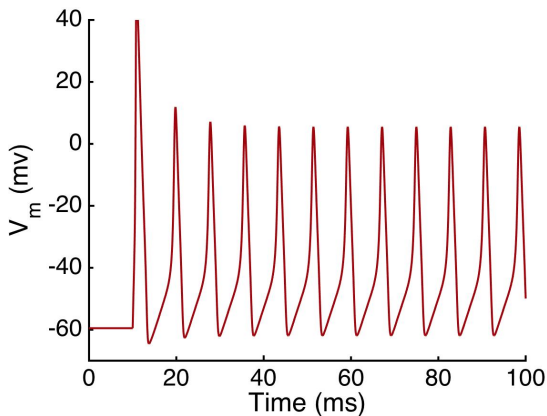


HH Model Action Train

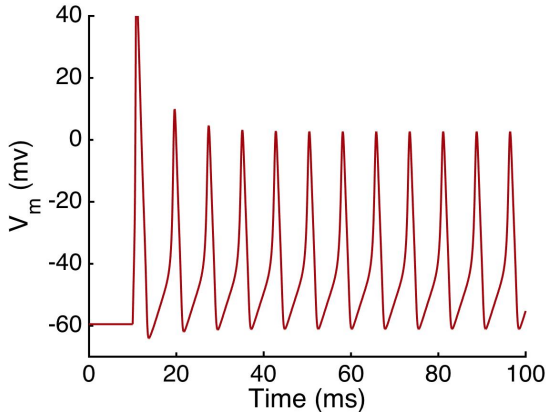


Stepping to $60 \mu A/cm^2$

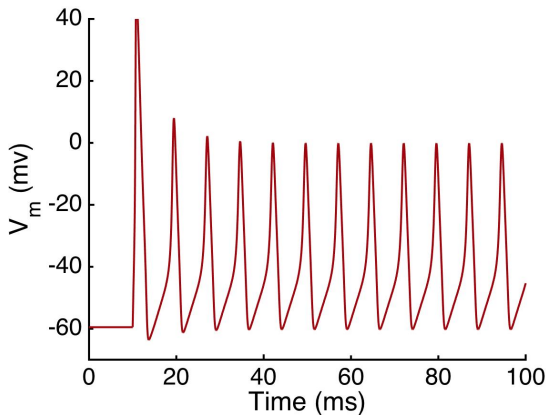
HH Model Action Train



HH Model Action Train

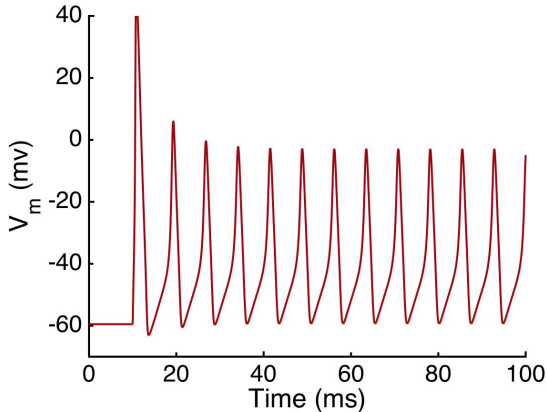


HH Model Action Train



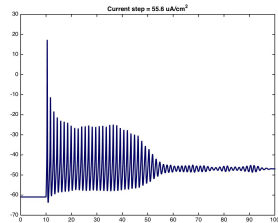
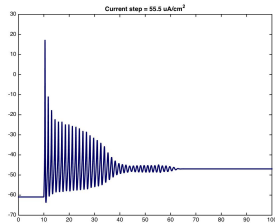
Stepping to $75 \mu A/cm^2$

HH Model Action Train



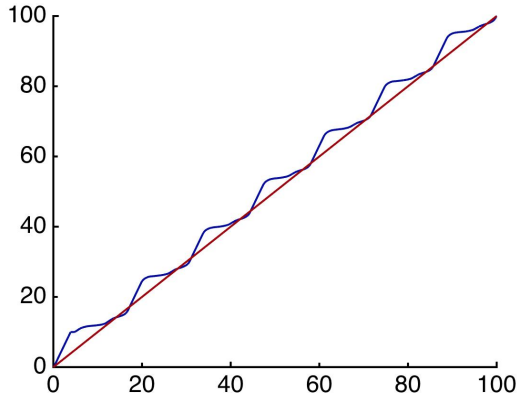
Stepping to 80 $\mu A/cm^2$

Anomalies With Default HH Model Settings



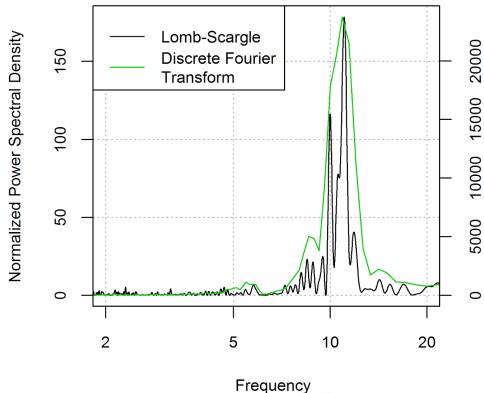
Incorrect behavior due to low precision

Fourier Transform Insufficient: Inconsistent Time Intervals



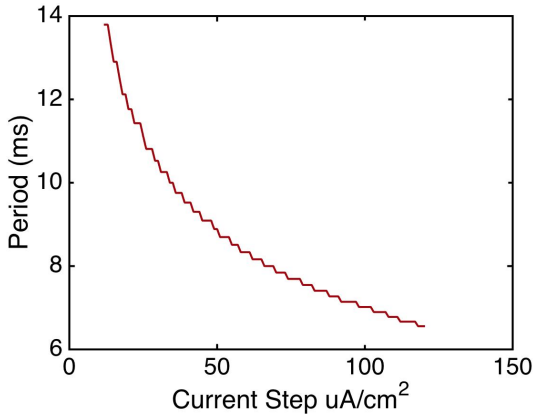
FFT insufficient, need a better Spectral Analysis Method

Least-Squares Spectral Analysis



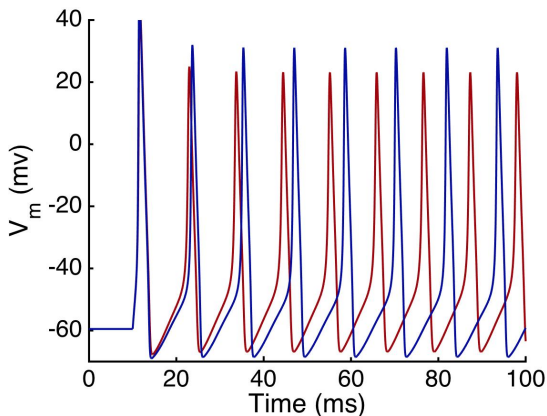
The Lomb-Scargle Periodogram works with variable intervals.

Graphing the Train Period



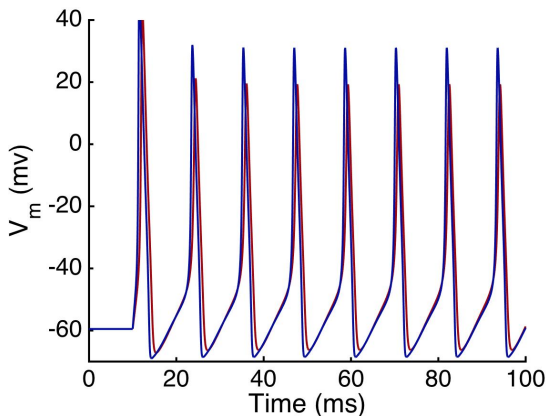
Nonlinearity shows complexity of behavior

Naive Mechanism



Equal ratio of current to capacitance

Mechanism



Unequal ratio of current to capacitance

Conclusion

- 1 Clear definition of saturation threshold
- 2 High accuracy prediction of cell response
- 3 Refuted possible simplification
- 4 Innovative experimental method

References

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- 2 Weiss, T. F. (1995). Cellular Biophysics. Volume 2: Electrical Properties, MIT Press.
- 3 Blaustein, M.P., Kao, J.P.Y., Matteson, D.R. (2012). Cellular Physiology and Neurophysiology, 2nd edition, Elsevier-Mosby.
- 4 Gerstner, Wulfram, and Werner M. Kistler. Spiking neuron models: Single neurons, populations, plasticity. Cambridge university press, 2002.
- 5 Press, William H., and George B. Rybicki. "Fast algorithm for spectral analysis of unevenly sampled data." The Astrophysical Journal 338 (1989): 277–280.