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CLAB 5: Dynamical Systems Approach to Neuron Modelling

The Reduced HH model is still capable of producing an action potential. Such is shown in Figure 1. A comparison with an action potential produced using the original HH model is shown in Figure 2.

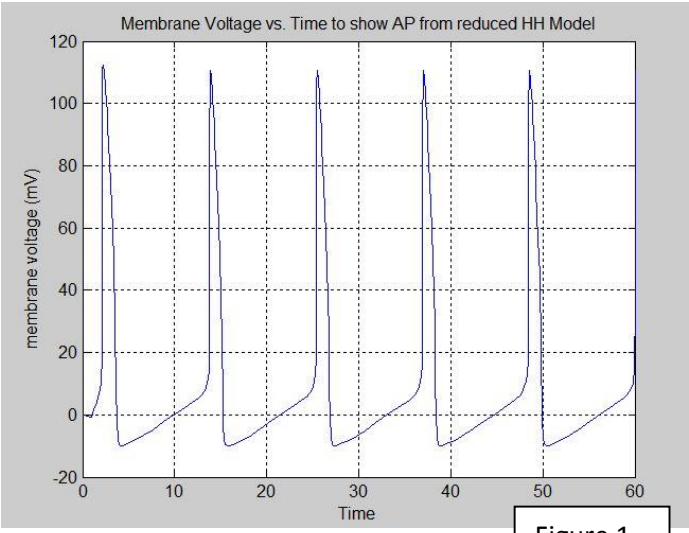

Figure 1

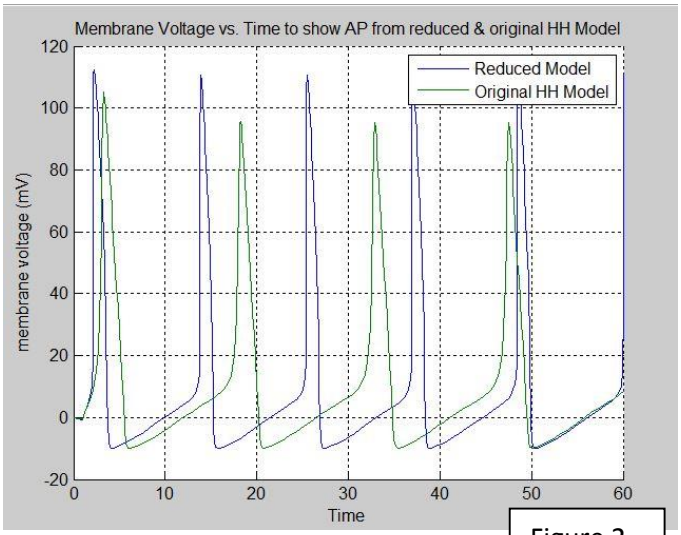

Figure 2

Figures 3 and 4 show the sub threshold and suprathreshold responses of the reduced HH model. By combining V&m together as well as combining n&h together, the reduced model uses only 2 variables instead of the 4 required by the original HH model. This makes an analytical approach to understanding the model far easier.

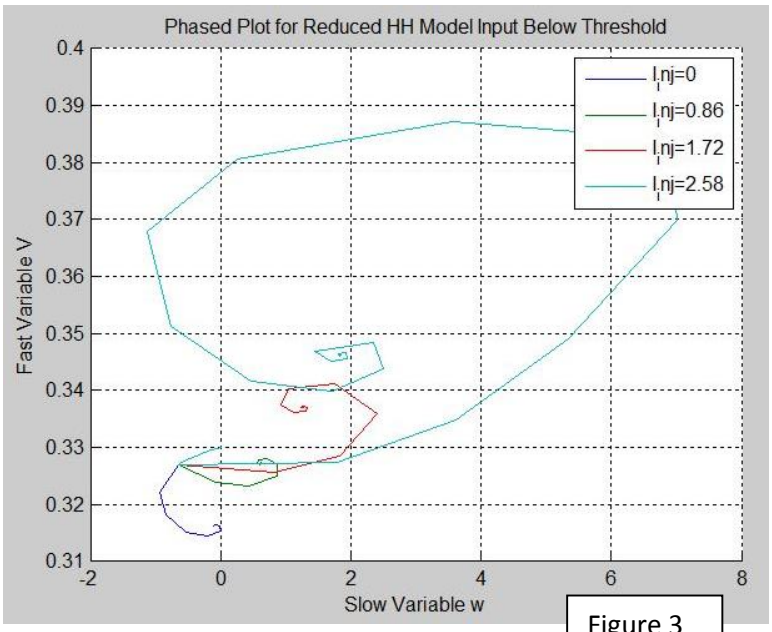

Figure 3

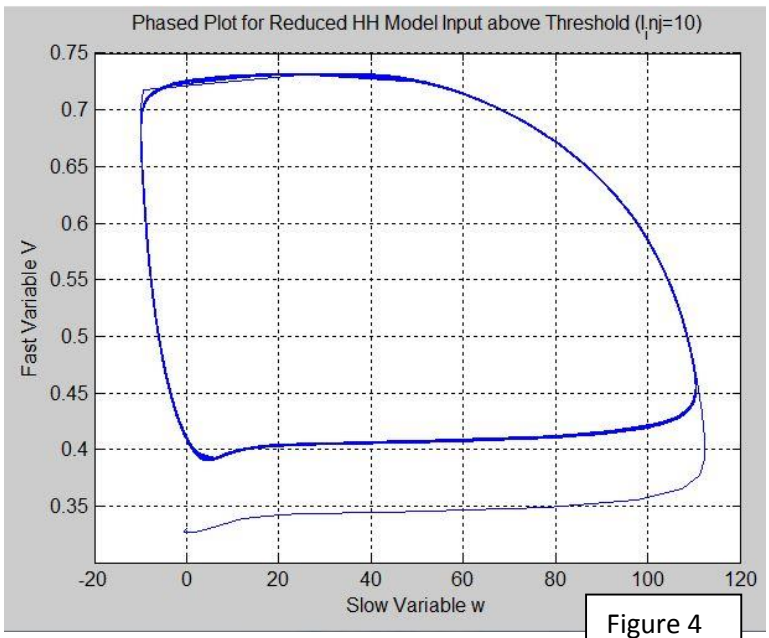

Figure 4

The dynamics shown in the graphs above are similar to those of the Fitz Nagumo Model shown in Figure 5.

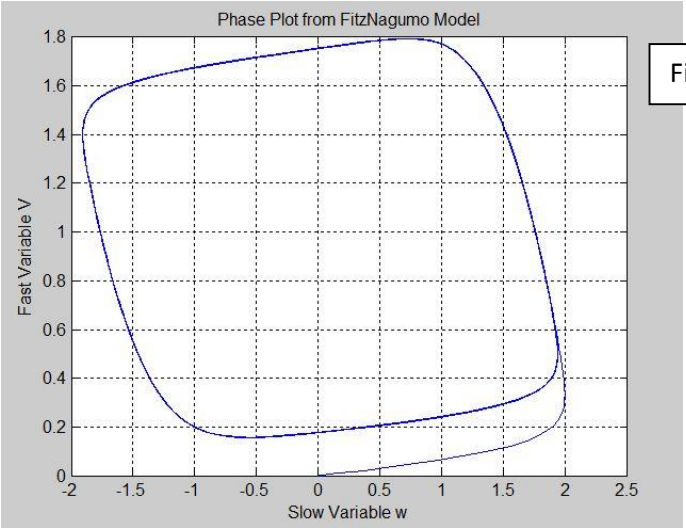

Figure 5

Despite being less realistic, the Fitz-Nagumo model also allows a viewer to see a graphical or geometrical explanation of the firing behavior in Neurons. In both models there is not a 100% defined threshold that corresponds to an all or nothing event, but instead a range of responses to stimuli that range from subthreshold to suprathreshold (see Fig3 and 4 for HH model range of response). The appearance of an all or nothing spiking behavior comes from the V null cline and its quick fall offs. If a trajectory trails too close, it will diverge... appearing to create a threshold behavior. Both models explain the repetitive excitation of a neuron with increasing injected current. As I_inj increases, the intersection of the null clines moves from the left most part of the V null cline to the right because the V null cline shifts up and the n null cline stays put. This is a movement from a stable left section to an unstable middle section where the model then predicts periodic spiking.

In figures 6, 7 & 8, plots of v vs. u are shown for 3 types of spiking behavior: Regular Spiking (RS), Chattering (CH) and Fast Spiking (FS), respectively.

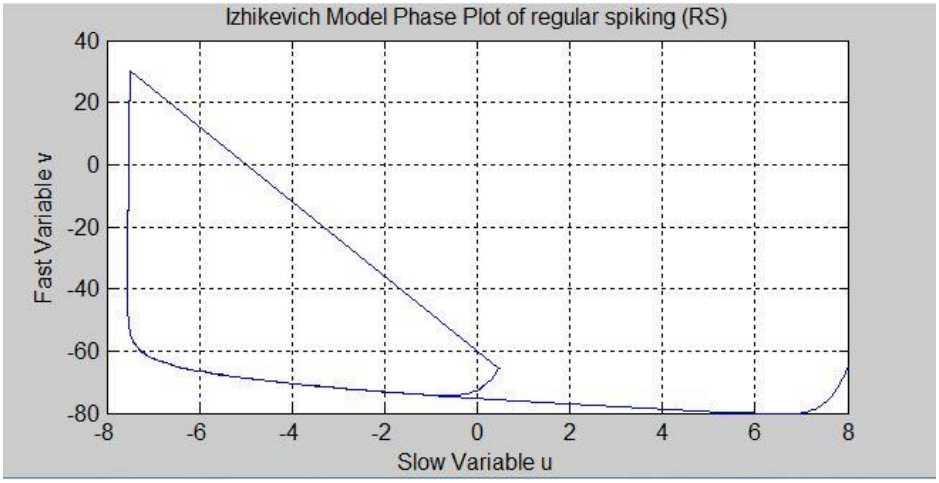

Figure 6

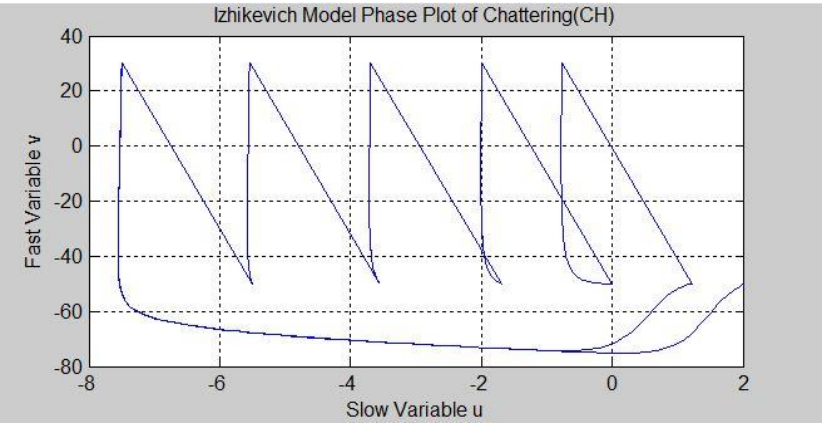

Figure 7

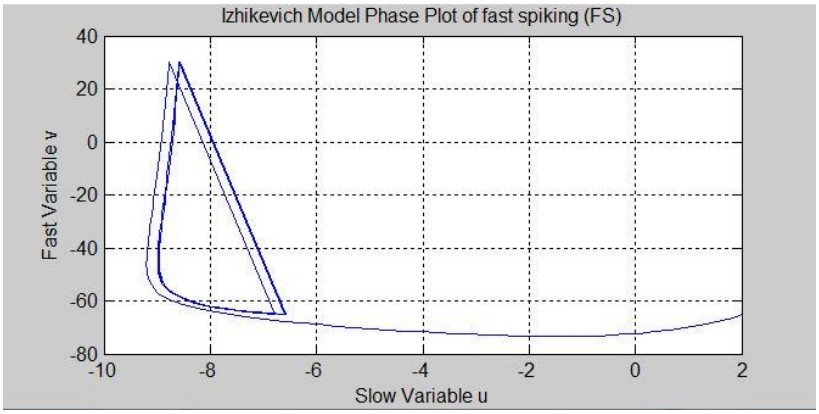

Figure 8

Discussants:

1. Satish
2. Matt Everett