

# Modeling coherent slow-wave activity in the Drosophila central complex

(Report)

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## **Note**

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## **List of Questions**

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# 1 Testing Izhikevich Model

Testing dynamics of one neuron with parameters and external input currents as described in the manuscript.

The Izhikevich model [1]:

$$\frac{dv}{dt} = [0.04v^2 + 5v + 140 - u] \cdot 0.05 + I + I_{syn} \quad (1)$$

$$\frac{du}{dt} = [a(bv - u)] \cdot 0.05 \quad (2)$$

where  $v$  is the membrane potential,  $u$  is the recovery variable,  $I$  is the external current to the neuron,  $I_{syn}$  is the synaptic current driven by the spikes of the presynaptic neurons.  $a$  is the time scale of the recovery variable  $u$ ,  $b$  is the sensitivity of the recovery variable to sub-threshold fluctuations of the membrane potential,  $c$  is the reset value of the membrane potential after spike,  $d$  is the effect of slow  $K^+$  and  $Na^+$  conductances on the membrane potential recovery ( $u$  is increased by this amount after each spike),  $v_{thr}$  is the voltage threshold for spikes.

External input current is provided separately for each neuron and is given by:

$$I = I_0 + \sigma \cdot N(0, 1) \quad (3)$$

where  $I_0$  is the mean intrinsic current,  $\sigma$  is the scale for the noise level, and  $N(0, 1)$  is the standard normal distribution with mean 0 and variance 1.

For R5 cells the external input current  $I$  is reset after each spike. For helicon cells,  $I$  is reset at each time step of the simulation ( $dt = 1ms$ ).

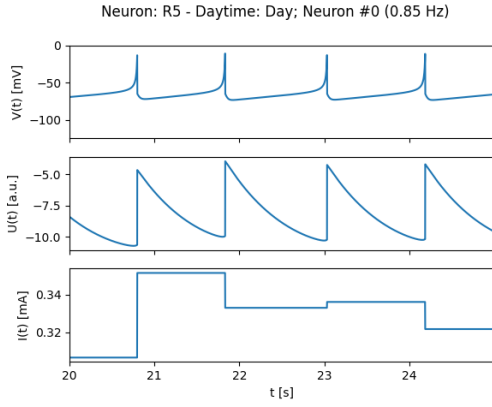
	$a$	$b$	$c$	$d$	$I_0$	$\sigma$	$v_{thr}$
R5 during day	0.02	0.2	-65	6	0.34	0.02	-10
R5 at night	0.02	0.3	-50	1.6	0.3	0.08	-10
Helicon during the day	0.02	0.2	-65	6	4.5	5	-10
Helicon during night	0.02	0.2	-65	6	-0.75	5	-10

Table 1: Parameters of the Izhikevich model for R5 and Helicon cells at morning and night

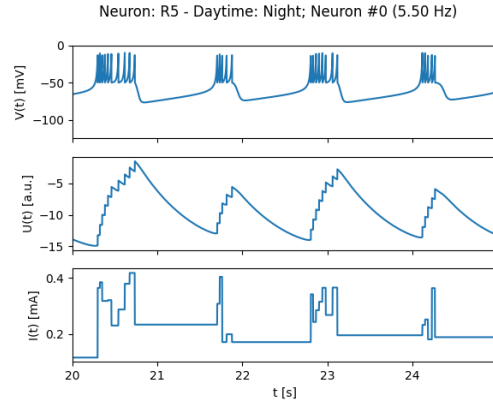
The results of the simulations are displayed in Fig. 1.

**Remark 1.** For the simulations, the standard deviation was normalized with regard to the simulation step size ONLY for helicon cells (see Remark 1 in the extended report).

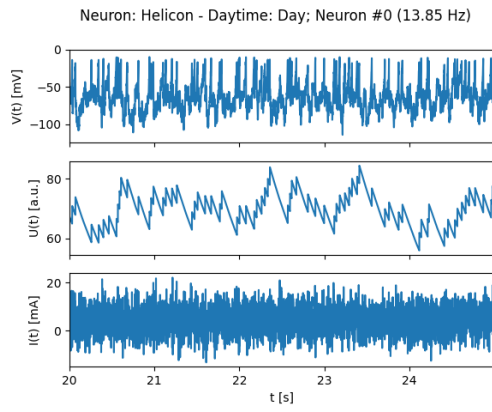
**Note 1.**



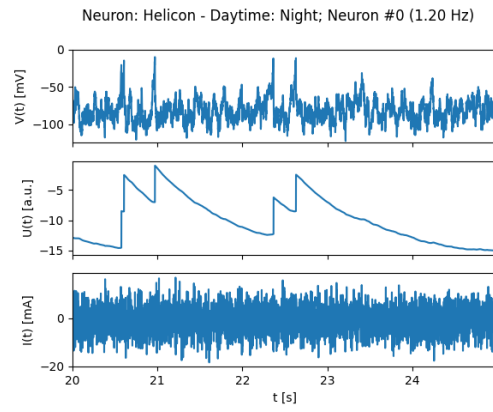
(a) R5 during the day



(b) R5 at night



(c) Helicon during the day



(d) Helicon at night

Figure 1: Comparison of R5 and Helicon at different times of day

## References

1. Izhikevich, E. Simple model of spiking neurons. *IEEE Transactions on Neural Networks* **14**, 1569–1572 (2003).