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· Supplementary File ·

Morris-Lecar model of third-order barnacle muscle fiber is made of volatile memristors

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Appendix A List of abbreviations of model parameters, and parameter values, of the third-order Memristive Morris-Lecar (ML) Model [1]

I – applied current ($\mu A/cm^2$)

I_{C_m} , I_L, I_{Ca} and I_K – current flowing through the axon membrane capacitor C_m, the leakage resistance R_L ($R_L = 1/g_L$), the time-varying calcium resistance R_{Ca} ($R_{Ca} = 1/g_{Ca}$), and the time-varying potassium resistance R_K ($R_K = 1/g_K$), respectively ($\mu A/cm^2$)

E_L, E_{Ca} and E_K – battery voltages connected in series with the leakage conductance, the calcium ion-channel memristor and the potassium ion-channel memristor, respectively (mV)

M , N – fraction of open $Ca^{++}$and K^+ ion-channels

M_∞ , N_∞ – fraction of open $Ca^{++}$and K^+ ion-channels at steady state

$\lambda_M(V)$, $\lambda_N(V)$ – rate constants for the opening of Ca^{++} and K^+ ion-channels, (s^{-1})

$\bar{\lambda}_M$, $\bar{\lambda}_N$ – maximum rate constant for Ca^{++} and K^+ ion-channel openings, (s^{-1})

V_1 and V_3 – potential (mV) at which M_∞ and N_∞ are equal to 0.5 mV, and

V_2 and V_4 – parameters (mV) associated with Eqs. (1d), (1e), (1f), and (1g)

Table 1. Parameter values [1] of the third-order memristive Morris–Lecar model

C_m	20 $\mu F/cm^2$	E_{Ca}	120 mV
E_K	−84 mV	g_{Ca}	4.4 mS/cm^2
g_K	8 mS/cm^2	V_1	−1.2 mV
V_3	2 mV	V_2	18 mV
V_4	30 mV	g_L	2 mS/cm^2
$\bar{\lambda}_N$	0.04 ms^{-1}	E_L	−60 mV
		$\bar{\lambda}_M$	0.8 ms^{-1}

Appendix B Frequency-dependent Pinched Hysteresis Loop of Calcium ion-channel memristor (a), and Potassium ion-channel memristor (b), at different frequencies

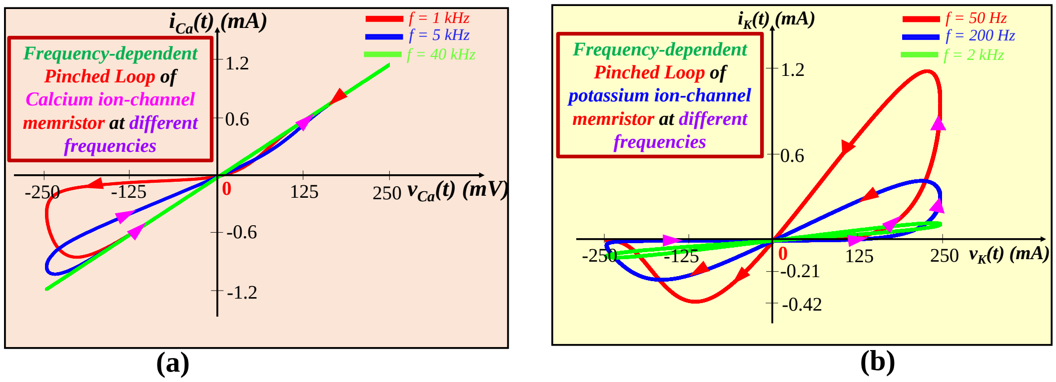

Figure B1 (a) Frequency-dependent pinched hysteresis loop of the calcium ion-channel memristor simulated at *f = 1 kHz, 5 kHz* and *40 kHz*, respectively with $v_{Ca}(t) = 250 \sin(2\pi ft)$; (b) Frequency-dependent pinched hysteresis loop of the potassium ion-channel memristor at *f = 50 Hz, 200 Hz*, and *2 kHz*, respectively with $v_K(t) = 250 \sin(2\pi ft)$;

Appendix C DRM of calcium ion-channel memristor, over the interval, $-100 \le M \le 200$ at v_{Ca} = -25, -15, 0, 15, 25 *mV*, and the DRM of potassium ion-channel memristor, over the interval, $-100 \le N \le 200$ at v_K = -25, -15, -8, 0, 15, 25 *mV*, respectively.

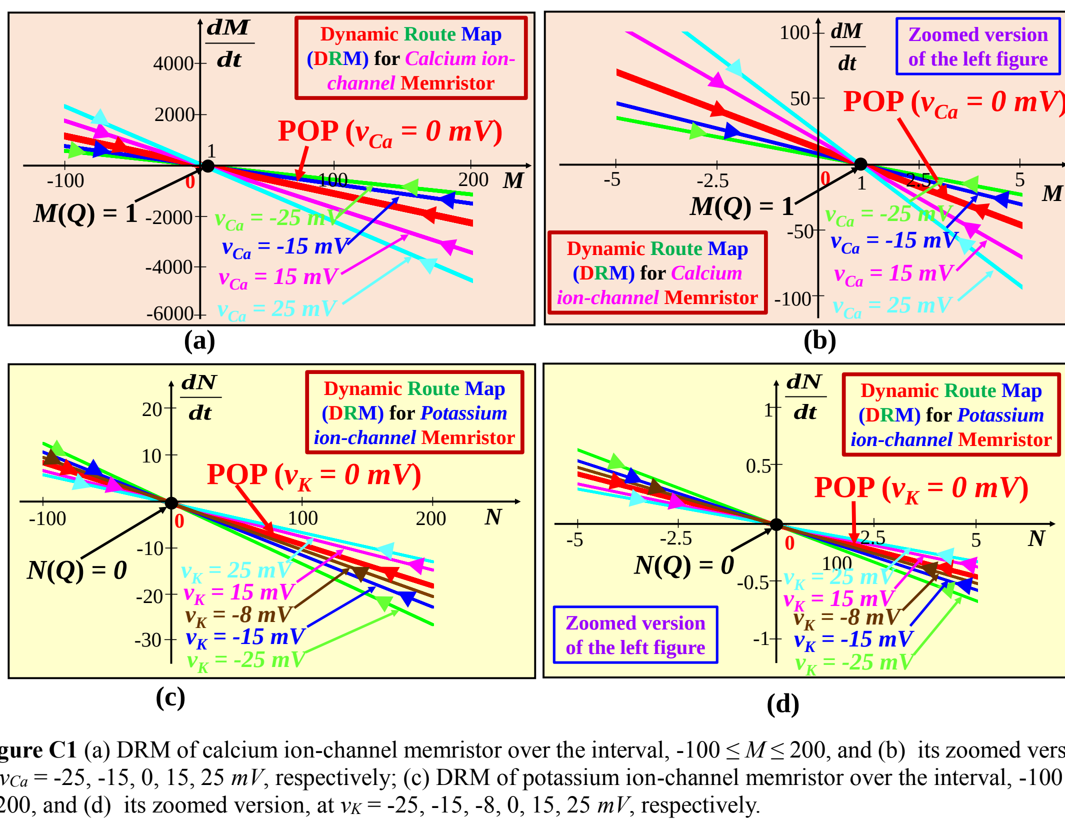

Figure C1 (a) DRM of calcium ion-channel memristor over the interval, $-100 \le M \le 200$, and (b) its zoomed version, at v_{Ca} = -25, -15, 0, 15, 25 *mV*, respectively; (c) DRM of potassium ion-channel memristor over the interval, $-100 \le N \le 200$, and (d) its zoomed version, at v_K = -25, -15, -8, 0, 15, 25 *mV*, respectively.

References

1 Ermentrout G, Terman D. Mathematical Foundations of Neuroscience. Springer, 2010