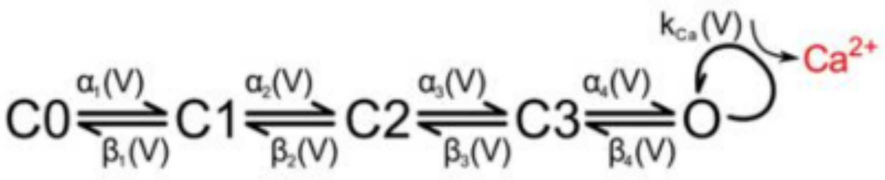
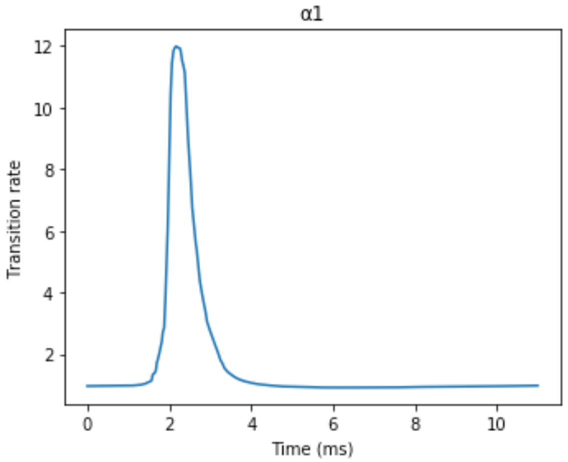
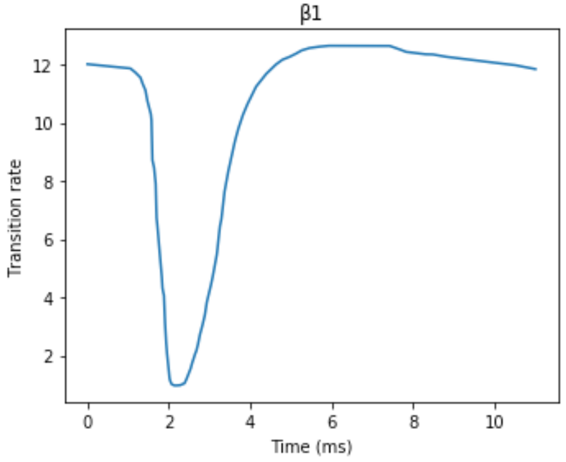
Paper Figures

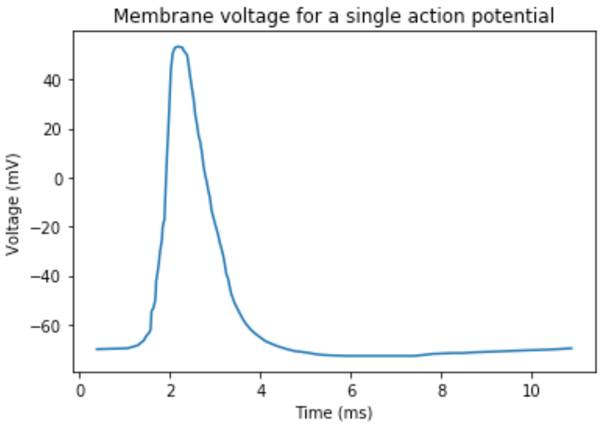
1. Multinomial Markov

Voltage-Gated Calcium Channel





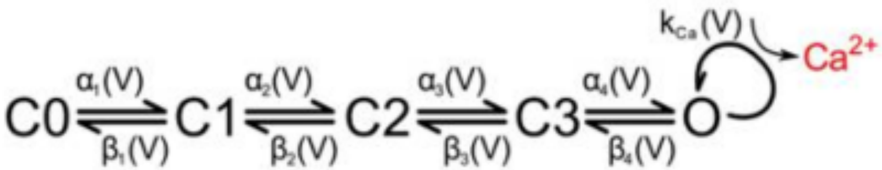


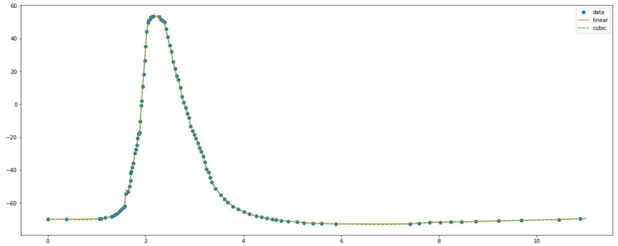


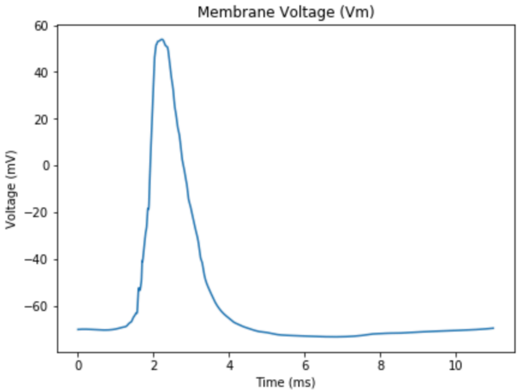
Transition rates: $\alpha_i(V) = \alpha_{io}\exp(V/V_i)$ $\beta_i(V) = \beta_{io}\exp(V/V_i)$

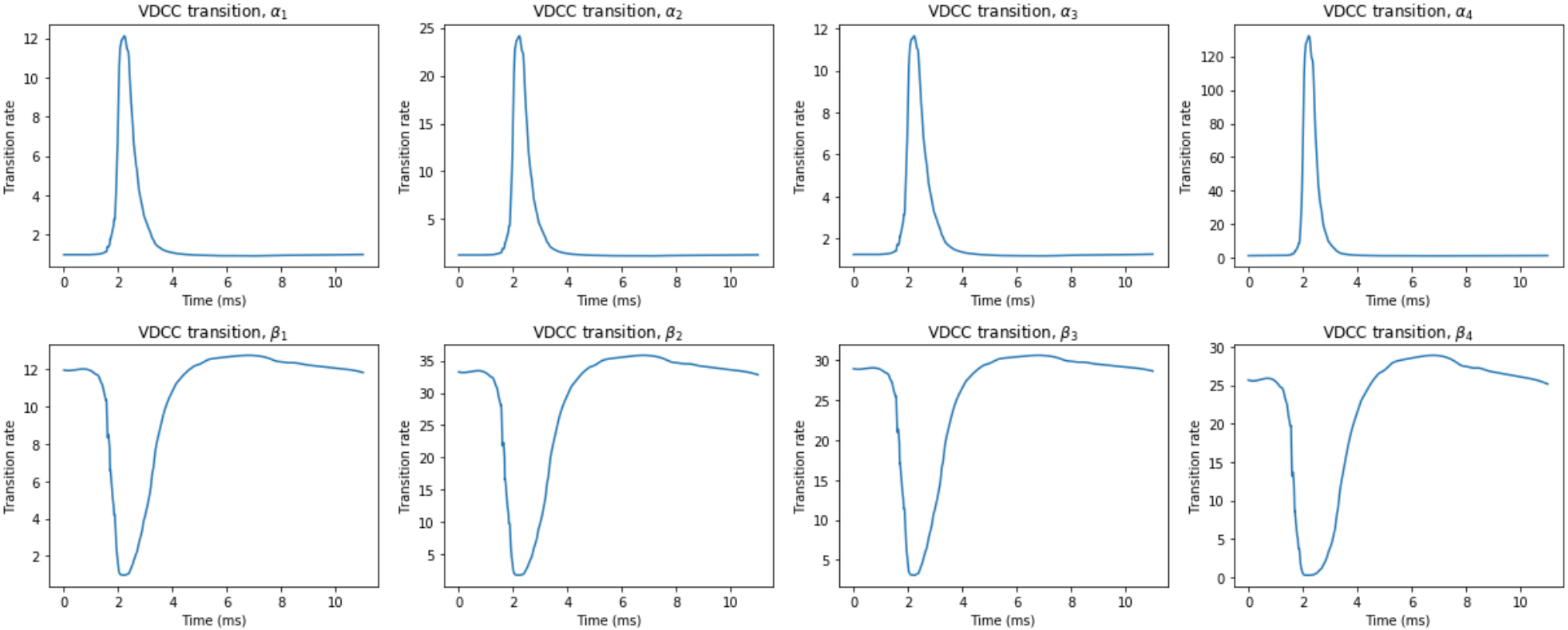
Transition probabilities: $\alpha_i \Delta t$ $\beta_i \Delta t$

Action Potential and State Transitions

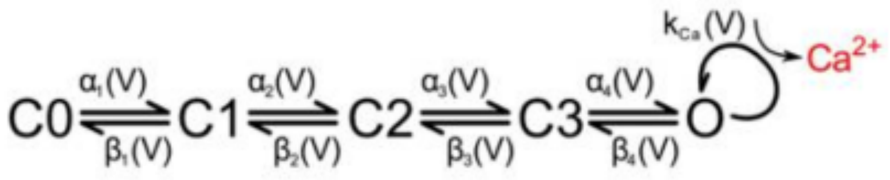




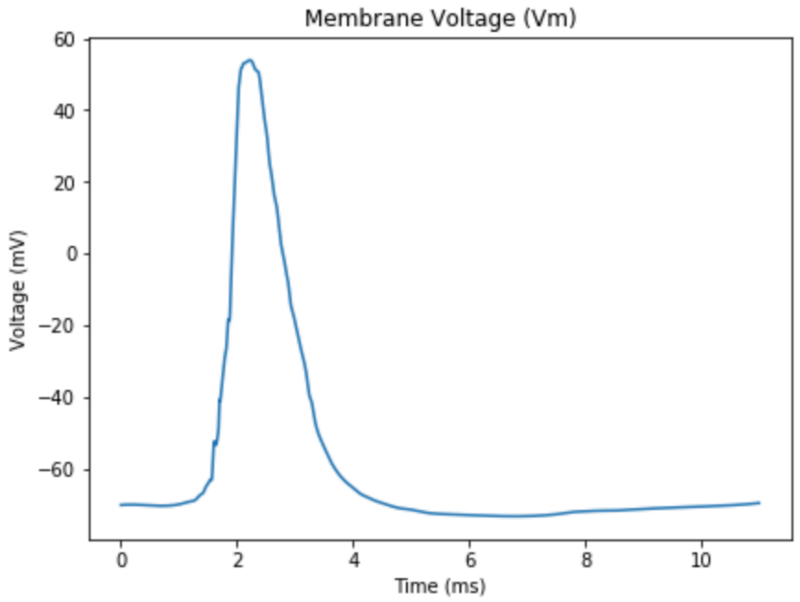


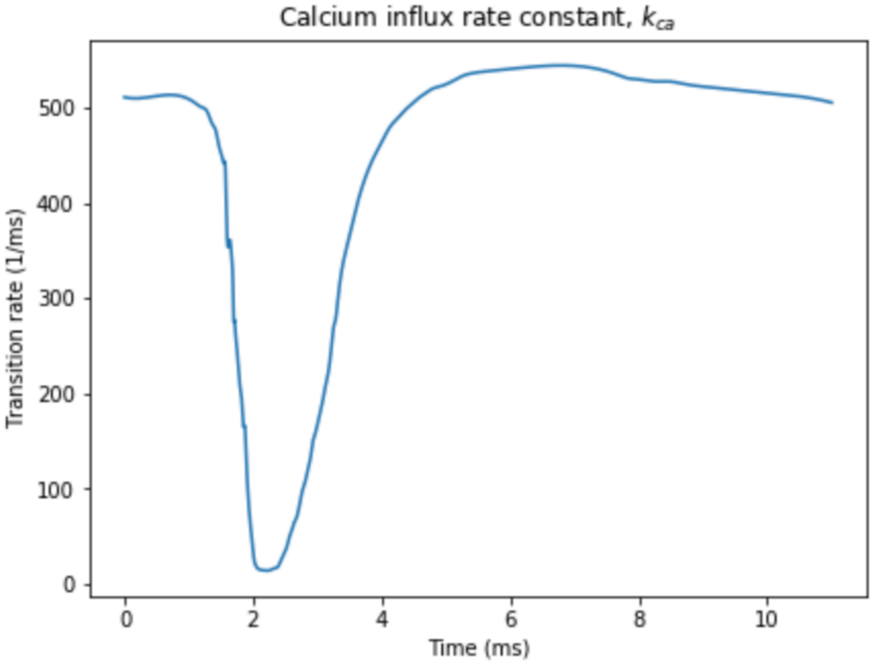


Calcium Influx



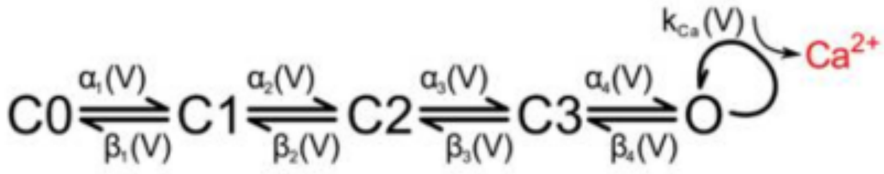
$$k_{Ca}(V_m) = \frac{\gamma V_m N_A \left(0.393 - e^{\frac{-V_m}{80.36}}\right)}{2F\left(1 - e^{\frac{V_m}{80.36}}\right)}$$





VDCC Solutions - MCell

VDCC Solutions - ODE



$$\frac{dC0}{dt} = \beta_1(V)C1 - \alpha_1(V)C0$$

$$\frac{dC1}{dt} = \alpha_1(V)C0 + \beta_2(V)C2 - (\beta_1(V) + \alpha_2(V))C1$$

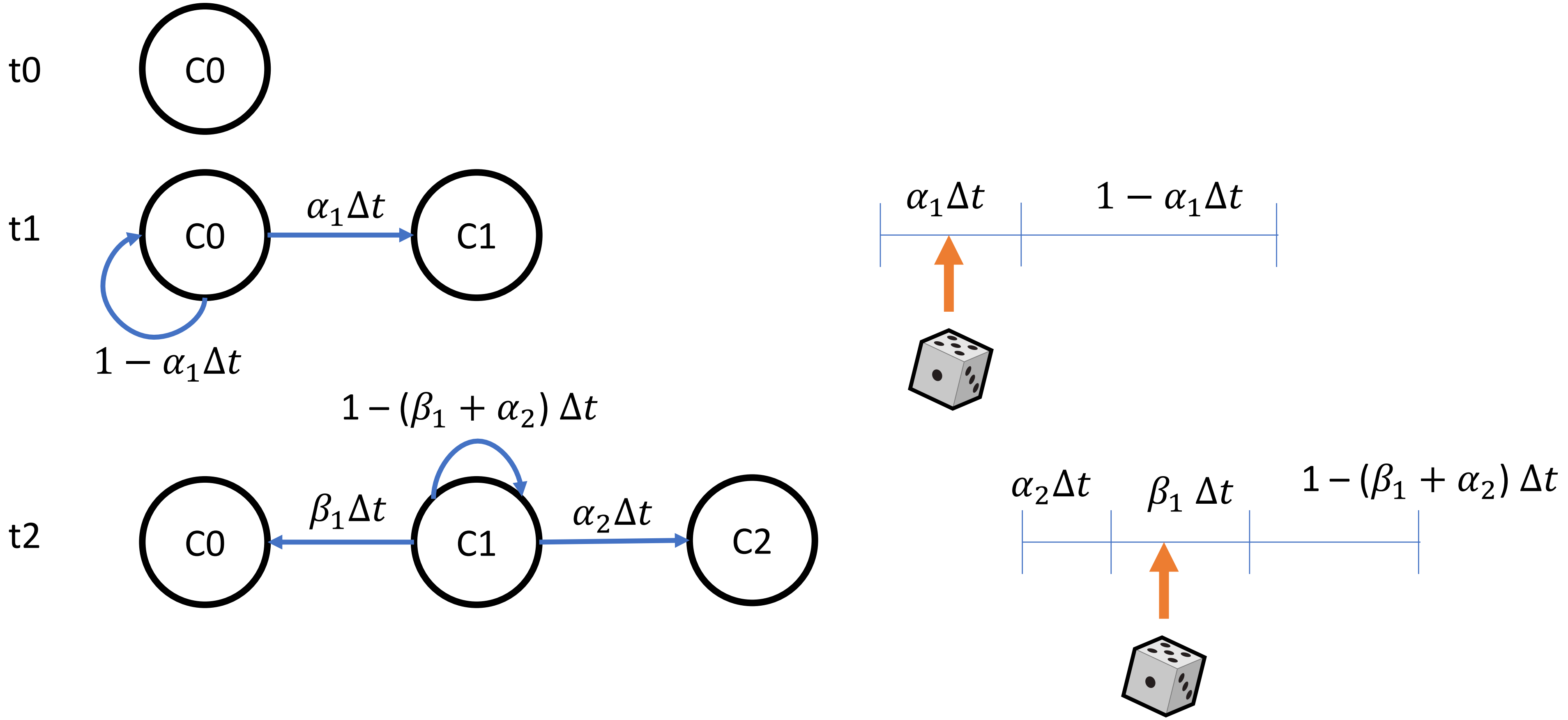
$$\frac{dC2}{dt} = \alpha_2(V)C1 + \beta_3(V)C3 - (\beta_2(V) + \alpha_3(V))C2$$

$$\frac{dC3}{dt} = \alpha_3(V)C2 + \beta_4(V)O - (\beta_3(V) + \alpha_4(V))C3$$

$$\frac{dO}{dt} = \alpha_4(V)C3 - \beta_4(V)O$$

$$\frac{dCa}{dt} = k_{Ca}(V)O$$

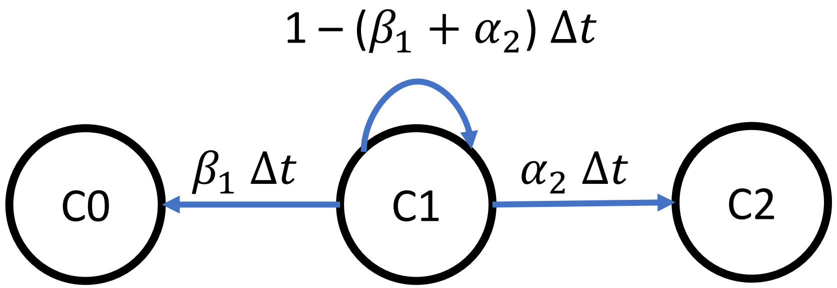
VDCC Solutions - Markov



1. Sample for Unif
2. Compare to probabilities to find out

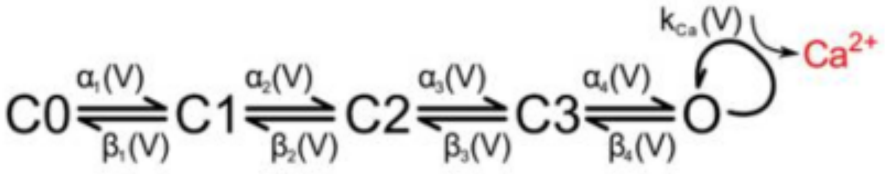
VDCC Solutions – Multinomial Markov

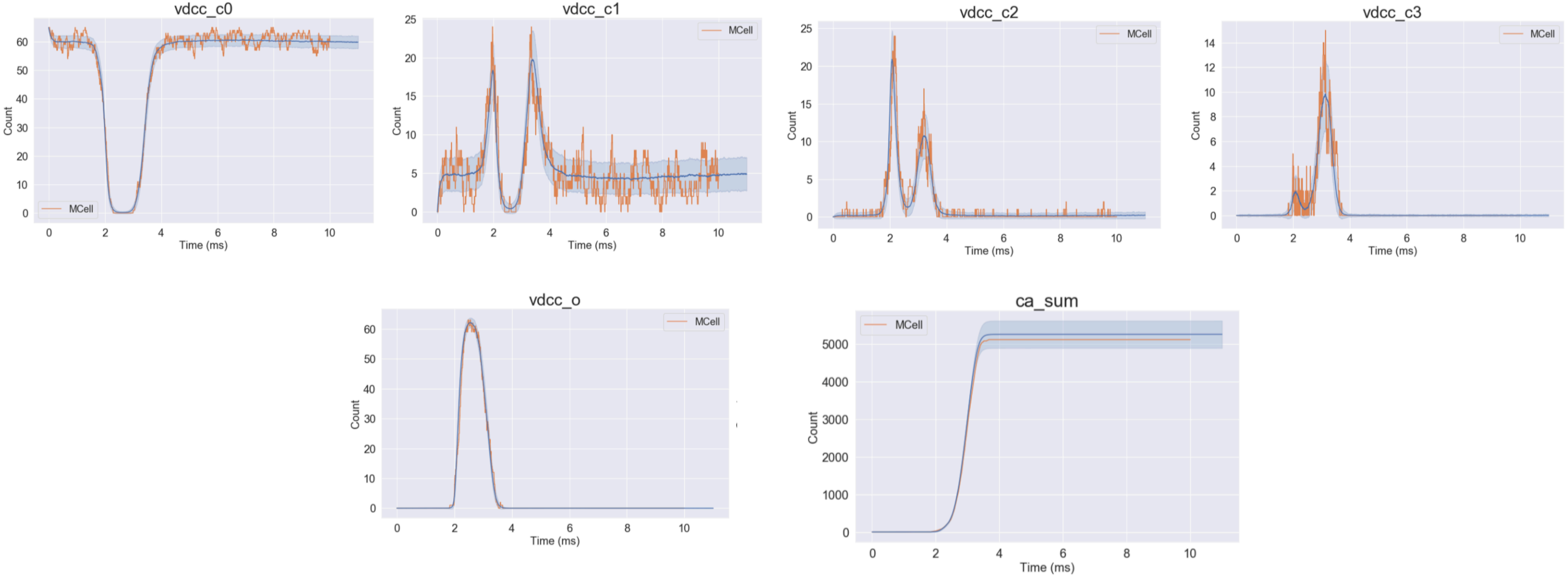
$P_{C1\rightarrow C2} = \alpha_2\ \Delta t$
$P_{C1\rightarrow C0} = \beta_1\ \Delta t$
$P_{C0\rightarrow C0} = \beta_1\ 1-(\beta_1+\alpha_2)\ \Delta t$



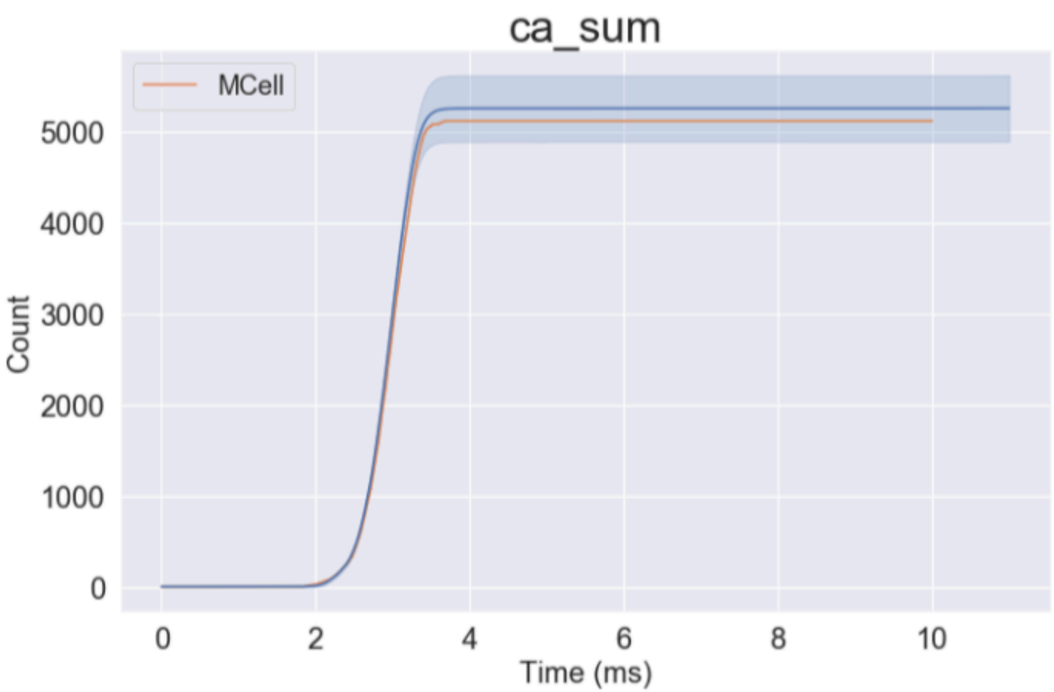
	$P_{C1\rightarrow C2}$	$P_{C1\rightarrow C0}$	$P_{C0\rightarrow C0}$	
n = 1 channel	0	1	0	$\sum = 1$
n = 20 channels	4	9	7	$\sum = 20$

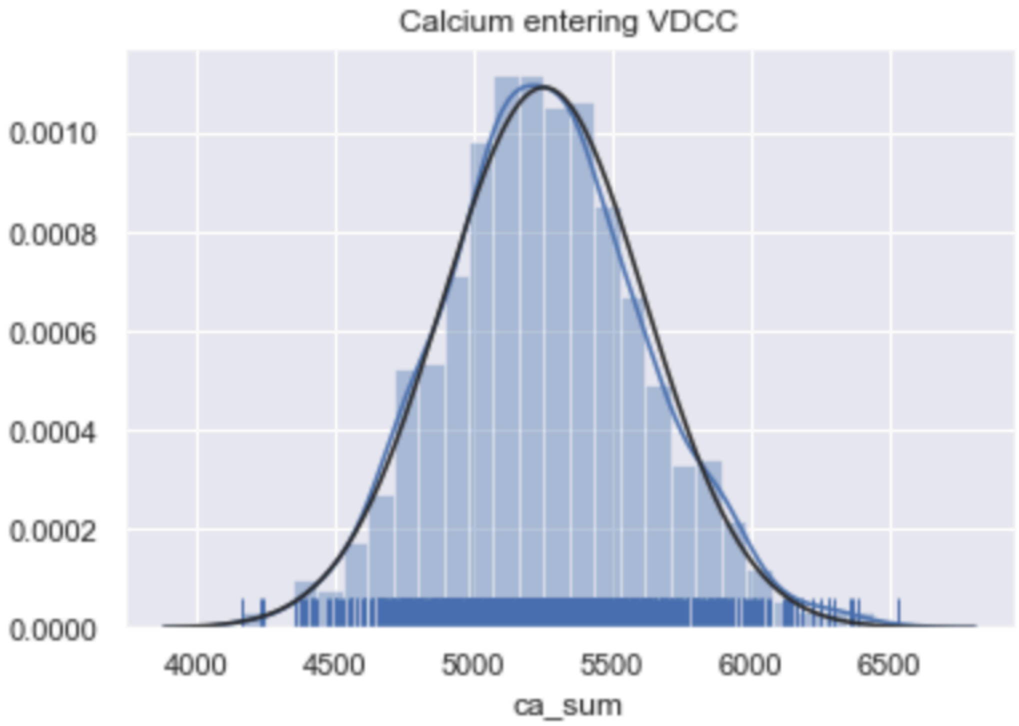
VDCC Solutions Comparison





Calcium Influx

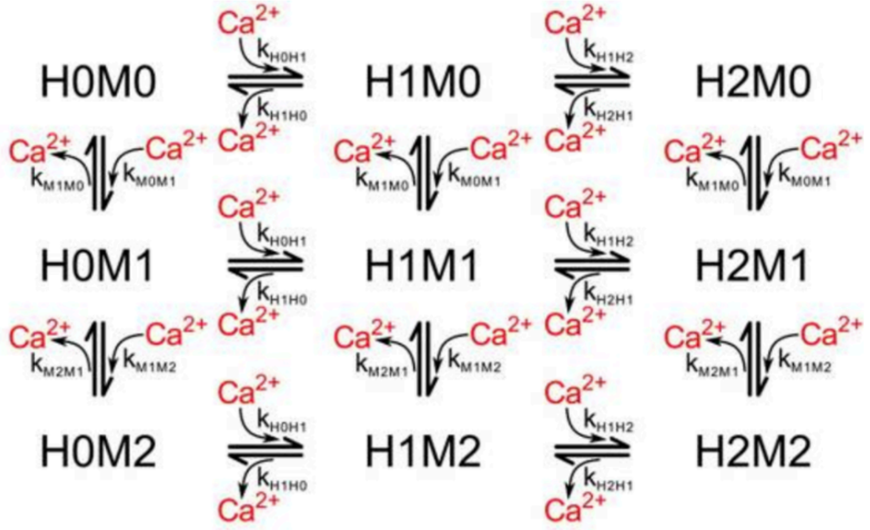




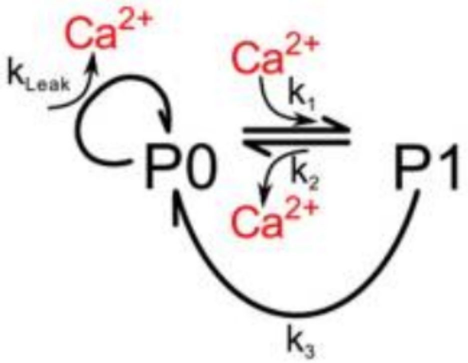
2. Operator Splitting

Calcium binding and diffusion upon influx into axon.

Calcium Binding

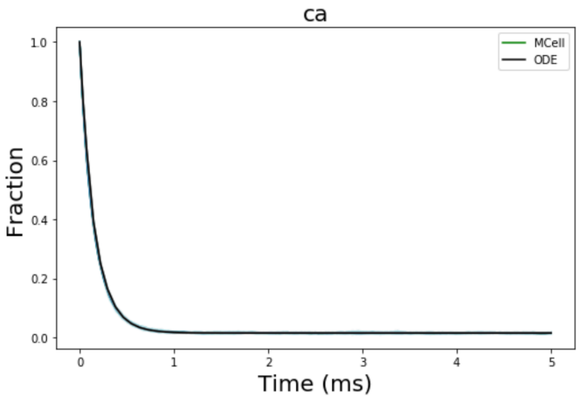


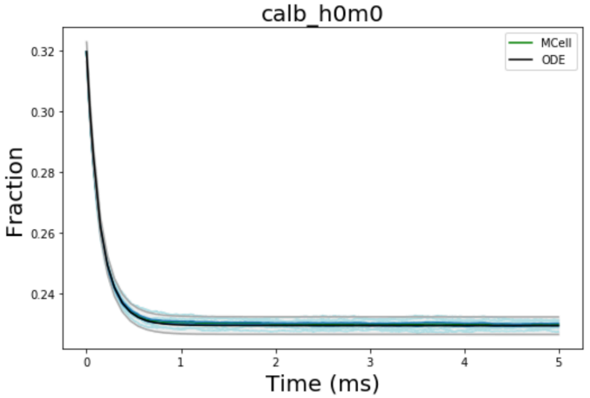
Calbindin-D28k

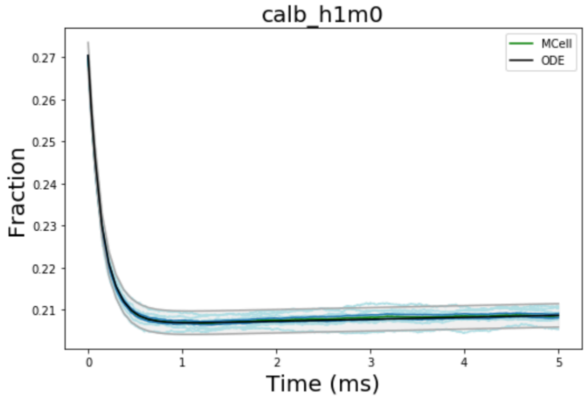


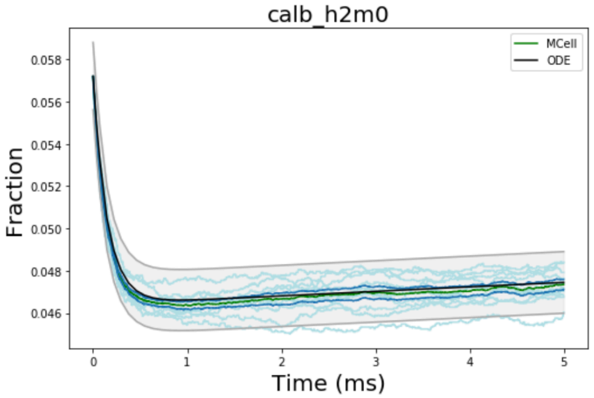
PMCA

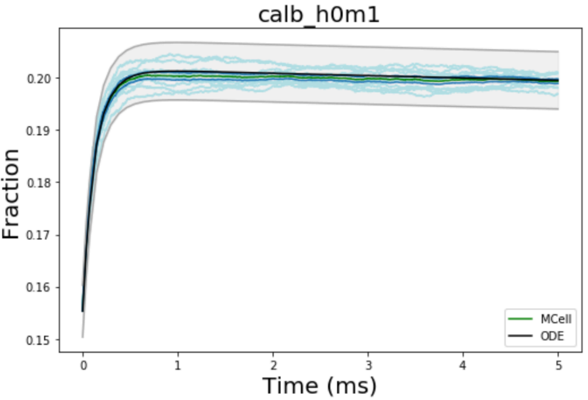
Impact of Calbindin

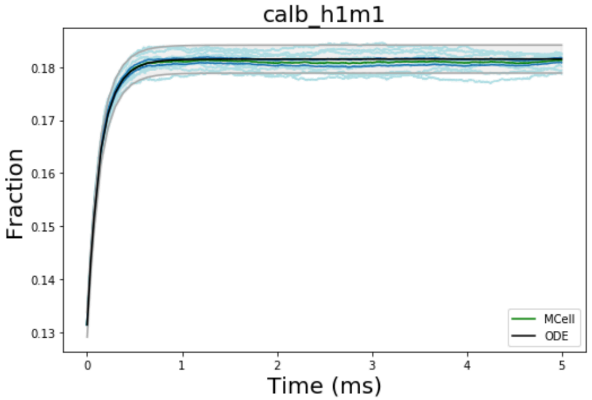


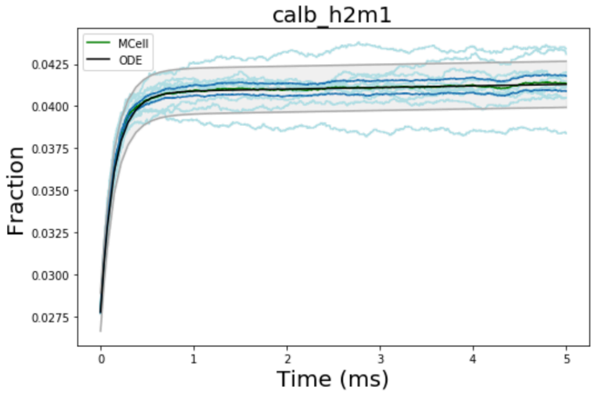


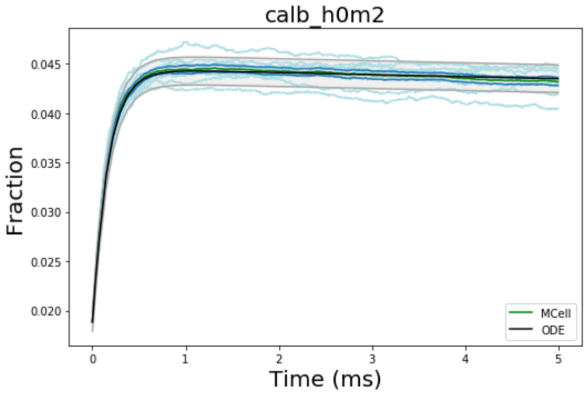


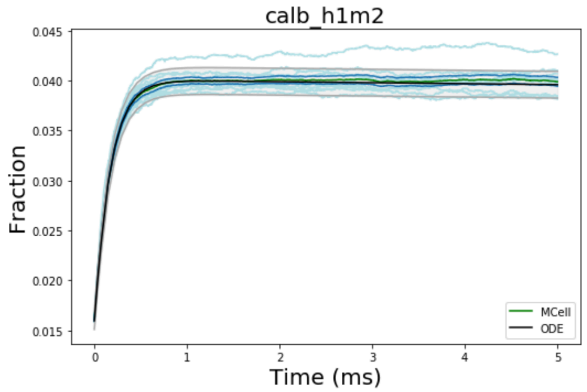


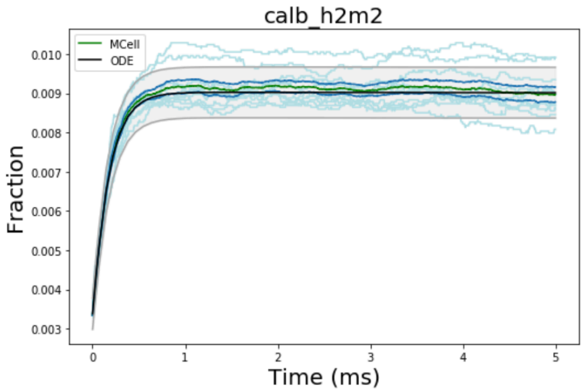


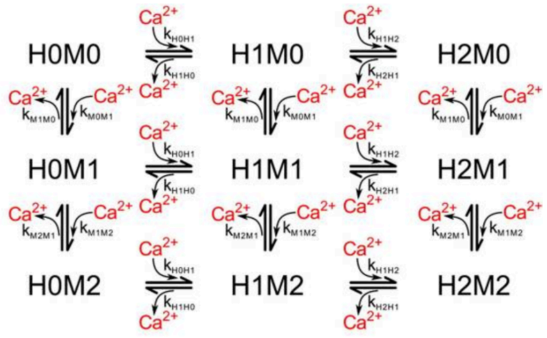












Calbindin-D28k

Impact of PMCA