Stochastic Models
Stochastic, Oscillatory Gene Expression

Stochastic, Circadian Fluctuations in Period Gene Expression

Stochastic, Ultradian and Circadian Oscillations in CORT Secretion

Setup for Patch Clamp Recordings
Cell-Attached Patch Clamp Recording

Recording from a patch of membrane containing approximately 4 ion channels (maybe more, but not less)
Monte Carlo Simulation of a Single Ion Channel

A $k^+ = 0.1$, $k^- = 0.1$

B $k^+ = 0.2$, $k^- = 0.2$

C $k^+ = 0.2$, $k^- = 0.05$
Monte Carlo Simulation of 4 Ion Channels

$k^+ = 0.1, k^- = 0.1$

$k^+ = 0.2, k^- = 0.2$

$k^+ = 0.2, k^- = 0.05$
Binomial Distributions

A. $p = 1/2$

B. $p = 1/2$

C. $p = 1/2$

D. $p = 1/2$

E. $p = 3/4$

F. $p = 3/4$

G. $p = 3/4$

H. $p = 3/4$

$N=2$ $N=20$ $N=100$ $N=1000$
Deterministic Morris-Lecar Model

Deterministic Morris-Lecar with small-amplitude sinusoidal input
Stochastic Morris-Lecar Model

Stochastic Morris-Lecar (N=20) with small-amplitude sinusoidal input
Stochastic Morris-Lecar Model

Stochastic Morris-Lecar (N=100) with small-amplitude sinusoidal input. The spiking frequency is approximately that of the forcing frequency.
Stochastic Morris-Lecar Model

Stochastic Morris-Lecar (N=1000) with small-amplitude sinusoidal input. The cell rarely spikes.
Stochastic Morris-Lecar Model

Summary of the response vs. number of channels
Double-Well Potential

\[ V(x) \]

\[ \Delta V \]
Stochastic Resonance with a Double-Well Potential

Sinusoidal signal (green) alters the shape of the potential function. The size of the circle reflects the probability that the particle is in a particular well.