**Synaptic Input - Driving Force**

\[
I_{synaptic} = (E_{synaptic} - V_m)G_{synaptic}
\]

\[
C_m \frac{dV_m}{dt} = (E_{leak} - V_m(t))G_{leak} + (E_{syn} - V_m(t))G_{syn}(t) + I_{injected}
\]

EPSC, IPSC, EPSP, IPSP are not good as measure of input
Intensity of synaptic input =>

average over a small window
where mean $V_m$ don’t change much

Thus,

$$C_m \frac{dV_m}{dt} \approx 0$$

How big a window? Small enough that stationarity is a good approximation and large enough to average out fluctuations. Typically 200-500 ms is appropriate.
Two equations with two unknown:

\[ G_{total} = G_e + G_i + G_{leak} \]

\[ (E_{leak} - V_m)G_{leak} + (E_e - V_m)G_e + (E_i - V_m)G_i - I_{injected} = 0 \]

Now, solve for Gi and Ge…
G

leak is measured during quiescence. If only we could measure \( G_{tot} \), we would have \( G_e \) and \( G_i \)….

\[
G_e = \frac{I_{injected} + G_{total}(V_m - E_i) + G_{leak}(E_i - E_{leak})}{E_e - E_i}
\]

\[
G_i = G_{total} - G_{leak} - G_e
\]

G

leak is measured during quiescence. If only we could measure \( G_{tot} \), we would have \( G_e \) and \( G_i \)….
TURTLE SCRATCH REFLEX

G. A. ROBERTSON AND P. S. G. STEIN

Robertson & Stein J Physiol 1988
Activation of network
-73 mV
50 mV
Mechanical Stimulus
Intracellular recording
5 sec

50 mV
-73 mV
5 sec
Experiment
Berg, Alaburda, Hounsgaard  Science 2007
RESULT - BALANCED INHIBITION/EXCITATION

Berg, Alaburda, Hounsgaard  Science 2007
Berg, Alaburda, Hounsgaard  Science 2007
Borg-Graham, Monier, and Fregnac

Borg-Graham, Monier, and Fregnac  Nature 1998
Shu, Hasenstaub, and McCormick  Nature 2003
Chaos in neuronal networks with balanced excitatory and inhibitory activity.

Temporal structure of the inputs and activity of a single excitatory unit. The upper panel shows the total excitatory input (consisting of external input and excitatory feedback) (upper trace) and the total inhibitory input (lower trace), as well as the net input (middle trace). The currents are shown in units of the threshold (dashed line).

Below, the times when the cell switched to the active state are indicated.

The mean activity of the excitatory neurons (solid line) and the inhibitory ones (dashed line) as functions of the activity of the external units. The activities correspond to firing rates divided by their maximum value.