Physical System

Squid axon

Model

Hodgkin–Huxley cable equations

$$\frac{D}{4R_a} \cdot \frac{\partial^2 V}{\partial x^2} = C_m \frac{\partial V}{\partial t} + \overline{g}_{na} m^3 h \cdot (V - E_{na}) + \overline{g}_k n^4 \cdot (V - E_k) + g_l \cdot (V - E_l)$$

$$\begin{array}{lll}
\frac{dm}{dt} = - \ {}_m m + \beta_m \cdot (1 - m) & {}_m = \frac{.1(V+40)}{1-e^{-.1(V+40)}} & \beta_m = 4e^{-(V+65)/18} \\
\frac{dh}{dt} = - \ {}_h h + \beta_h \cdot (1 - h) & {}_h = .07e^{-.05(V+65)} & \beta_h = \frac{1}{1+e^{-.1(V+35)}} \\
\frac{dn}{dt} = - \ {}_n n + \beta_n \cdot (1 - n) & {}_n = \frac{.01(V+55)}{1-e^{-.1(V+55)}} & \beta_n = .125e^{-(V+65)/80}
\end{array}$$

Simulation

NEURON representation

```
from neuron import h
axon = h.Section()
axon.nseg = 75
axon.diam = 100
axon.L = 20000
axon.insert('hh')
```

Physical System

Model

Simulation

Squid axon

Hodgkin–Huxley cable equations

$$\frac{D}{4R_a}\cdot\frac{\partial^2 V}{\partial x^2} = C_m\frac{\partial V}{\partial t} + \overline{g}_{na}m^3h\cdot(V-E_{na}) + \overline{g}_k n^4\cdot(V-E_k) + g_l\cdot(V-E_l)$$

$$\frac{dm}{dt} = -\ {}_m m + \beta_m\cdot(1-m) \qquad {}_m = \frac{.1(V+40)}{1-e^{-.1(V+40)}} \qquad \beta_m = 4e^{-(V+65)/18)}$$

$$\frac{dh}{dt} = -\ {}_h h + \beta_h\cdot(1-h) \qquad {}_h = .07e^{-.05(V+65)} \qquad \beta_h = \frac{1}{1+e^{-.1(V+35)}}$$

$$\frac{dn}{dt} = -\ {}_n n + \beta_n\cdot(1-n) \qquad {}_n = \frac{.01(V+55)}{1-e^{-.1(V+55)}} \qquad \beta_n = .125e^{-(V+65)/80}$$

NEURON representation

```
from neuron import h
axon = h.Section()
axon.nseg = 75
axon.diam = 100
axon.L = 20000
axon.insert('hh')
```

Physical System

Squid axon

Model

Hodgkin–Huxley cable equations

$$\frac{D}{4R_a} \cdot \frac{\partial^2 V}{\partial x^2} = C_m \frac{\partial V}{\partial t} + \overline{g}_{na} m^3 h \cdot (V - E_{na}) + \overline{g}_k n^4 \cdot (V - E_k) + g_l \cdot (V - E_l)$$

$$\frac{dm}{dt} = - \ {}_m m + \beta_m \cdot (1 - m) \qquad {}_m = \frac{.1(V+40)}{1-e^{-.1(V+40)}} \qquad \beta_m = 4e^{-(V+65)/18)}$$

$$\frac{dh}{dt} = - \ {}_h h + \beta_h \cdot (1 - h) \qquad {}_h = .07e^{-.05(V+65)} \qquad \beta_h = \frac{1}{1+e^{-.1(V+35)}}$$

$$\frac{dn}{dt} = - \ {}_n n + \beta_n \cdot (1 - n) \qquad {}_n = \frac{.01(V+55)}{1-e^{-.1(V+55)}} \qquad \beta_n = .125e^{-(V+65)/80}$$

NEURON representation

```
from neuron import h
axon = h.Section()
axon.nseg = 75
axon.diam = 100
axon.L = 20000
axon.insert('hh')
```

Simulation