

BA-1

A Stochastic Model of Voltage-Gated Ion Channel

Kwonmoo Lee*, Wokyung Sung, and Gabriel Weinreb¹

Department of Physics, Pohang University of Science and Technology, Pohang, Korea and ¹Institute for Physics, Kiev, Ukraine

We model the voltage-gated cation channel on the basis of stochastic process by taking into account transmembrane movement of S4 group interacting electrostatically with permeant ions. It is assumed that the interaction between the ion and S4 group is repulsive harmonic force and the ionic motion is much faster than that of the S4 group. By this time scale separation approximation, the mean force of permeant ions acting on the group can be calculated. This mean force, highly nonlinear with respect to the external condition of ion channel such as extra/intracellular ionic concentrations and transmembrane potential, gives rise to various kinds of open and closed channel states. In other words, the fast permeant ions interacting with the slow S4 group renormalize the free energy of the S4 group of ion channel, bringing about self-organization effect. Using this model, we investigate open probability as a function of membrane potential and voltage-current relation modulated by bulk concentration.