"Stochastic Models in Neuroscience."

Michèle THIEULLEN

Laboratoire de Probabilités et Modèles Aléatoires
Univ. Pierre et Marie Curie, Paris, France.

In the nervous system phenomena with a high variability are frequent: highly irregular signals are observed experimentally, the response of a neuron to a given stimulation may vary from trial to trial. This variability is often referred to as *noise*. The aim of this course is to present some aspects of a probabilistic study of the neuronal activity of one single neuron considered as a building block of more complex neuronal assemblies. We will focus on the action potential generation and the impact of noise on it. We consider the patch-clamp situation only, which already gives rise to numerous mathematical questions. We will address two types of noise : the *external* noise which can be considered as resulting from the environment of a given neuron and the *intrinsic* noise which is the result of the stochastic opening of ion channels present along the membrane. The course will be structured as follows : we will first give a general presentation of possible mathematical models (deterministic and stochastic) for spike generation. Then we will consider questions specifically related to external or intrinsic noise. Both types of models present a time-scale separation. Models with external noise are more classical. One typical question for these models may be the first passage time of a given threshold. Models which take into account channel noise are more recent. They are more biophysically realistic. They provide an access to both the microscopic and the macroscopic levels of the neuron membrane and for instance they enable us to relate the noise with the number of channels involved. In both types of models many mathematical questions remain.