Séminaire de Probabilités et Statistiques

Mardi 16 janvier à 14h00

Laboratoire Dieudonné

Salle de Conférences

Héctor Olivero

(INRIA)

Synchronization of stochastic mean field networks of Hodgkin-Huxley neurons with noisy channels

In this work we are interested in a mathematical model for collective behavior of a fully connected network of finitely many neurons when their number and when time go to infinity. We assume that every neuron follows a stochastic version of the Hodgkin-Huxley model, and that pairs of neurons interact through both electrical and chemical synapses, the global connectivity being of mean field type. When the leak conductance is strictly positive, we prove that if the initial voltages are uniformly bounded and the electrical interaction between neurons is strong enough, then, uniformly in the number of neurons, the whole system synchronizes exponentially fast as time goes to infinity, up to some error controlled by (and vanishing with) the channels noise level. Moreover, for exchangeable random initial conditions and arbitrary interaction intensity, we prove that on every bounded time interval the propagation of chaos property for this system holds. Combining these results, we deduce that the nonlinear McKean-Vlasov equation describing an infinite network of such neurons concentrates, as times goes to infinity, around the dynamics of a single Hodgkin-Huxley neuron with a chemical neurotransmitter channel. Our results are illustrated and complemented with numerical simulations.
Joint work with Mireille Bossy and Joaquin Fontbona.