NUS National University of Singapore | IMS Institute for Mathematical Sciences

20 Celebrating years of Mathematical Synergy

DISTINGUISHED LECTURE SERIES

Professor Benoît Perthame
Sorbonne University, France

22 January 2020 (Wednesday), 11.15am–12.15pm
Auditorium, Institute for Mathematical Sciences

PDEs for neural assemblies; models, analysis and behavior

Neurons exchange information via discharges propagated by membrane potential which trigger firing of the many connected neurons. How to describe large assemblies of such neurons? How can such a network generate a collective activity?

Such questions can be tackled using nonlinear partial-integro-differential equations, which are classically used to describe neuronal assemblies. Among them, the Wilson-Cowan equations are the best known and describe globally brain spiking rates. Another classical model is the integrate-and-fire equation based on Fokker-Planck equations. The spike times distribution, which encodes more directly the neuronal information, can also be described directly thanks to structured population.

We will compare and analyze these models. A striking observation is that solutions to the so-called *Integrate and Fire equation* can blow up in finite time, a form of synchronization that can be regularized with a refractory stage. We can also show that for small or large connectivities the *elapsed time model* leads to desynchronization. For intermediate regimes, sustained periodic activity occurs compatible with observations. A common tool is the use of the relative entropy method.

Benoît Perthame is professor at Sorbonne University and member of the French Academy of Sciences. He has served for 7 years as director of Laboratory Jacques-Louis Lions. His awards include the Blaise Pascal Medal of European Academy of Sciences and the Inria Prize. He was invited speaker at the International Congress of Mathematicians in Zürich (1994), plenary speaker in Seoul (2014) and invited speaker at ICIAM 2015. Presently he is running the ERC Advanced Grant Adora. His research interests are in mathematical biology and include multiscale aspects of chemotaxis and cell populations self-organization, living tissues, neural networks and Darwinian evolution.

Photo by Anna Tremewan on Unsplash

Institute for Mathematical Sciences
3 Prince George's Park, Singapore 118402
www.ims.nus.edu.sg   ims@nus.edu.sg