IMS DISTINGUISHED VISITOR LECTURE SERIES

8 February 2023
10.30–11.30am, GMT +8 (Singapore Time)
IMS Auditorium

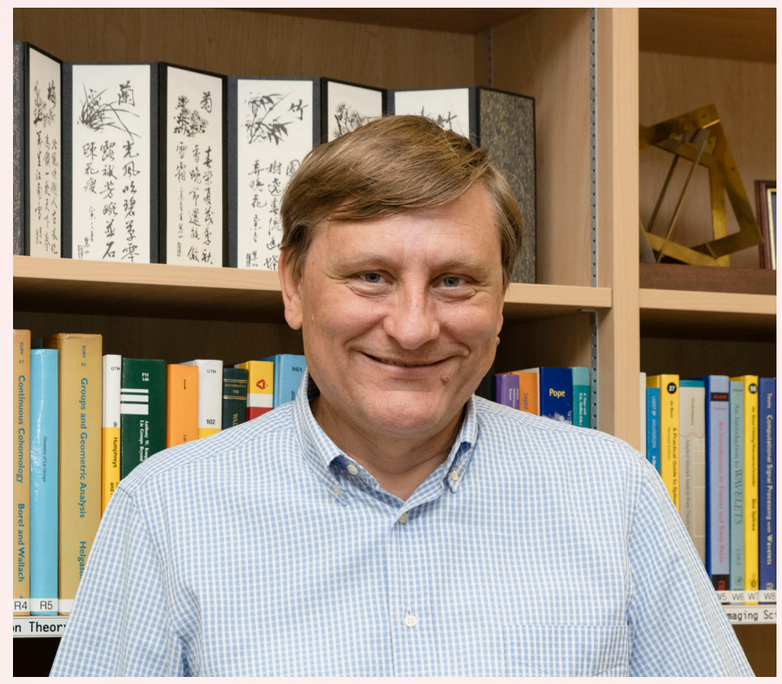
PDEs for neural assemblies; analysis, simulations and behaviour
Benoît Perthame

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? What are the properties of these mean-field equations? How can such a network generate a spontaneous activity?

Such questions can be tackled using nonlinear integro-differential equations. These are now classically used in the neuroscience community to describe neuronal assemblies. Among them, the best known is certainly Wilson-Cowan's equation which describe spiking rates arising in different brain locations.

Another classical model is the integrate-and-fire equation that describes neurons through their voltage using a particular type of Fokker-Planck equations. Several mathematical results will be presented concerning existence, blow-up, convergence to steady state, for the excitatory and inhibitory neurons, with or without refractory states. Conditions for the transition to spontaneous activity (periodic solutions) will be discussed.

One can also describe directly the spike time distribution which seems to encode more directly the neuronal information. This leads to a structured population equation that describes at time t the probability to find a neuron with time s elapsed since its last discharge.



Professor Benoît Perthame
Sorbonne University, France

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.

13 and 14 February 2023
10.00am–12.30pm, GMT +8 (Singapore Time)
IMS Auditorium

Mathematical analysis of models for living tissues and free boundary problems
Benoît Perthame

Mechanical models of tissue growth are now well settled with continuous inputs from medicine, biology, physics, mechanics and mathematics. They contain several levels of complexity, both in terms of the biomedical content and mathematical description, from ordinary differential equations to sophisticated partial differential equations. They serve to predict the evolution of cancers in medical treatments, to understand the biological effects that permit tumor growth and control by treatment, in some cases, their implication in therapies failure.

Based on the mechanical point of view that a living tissue behaves as a porous media, this course aims at deriving, incompressible, free boundary problems departing from compressible models.

The specific questions that will be addressed are
- Aspects of tumor growth modeleld by differential equations
- Mechanical models of tissue growth
- The incompressible limit and the free boundary problems
- Models with multiple species, with surface tension

The mini courses and talk are part of the program on
Multiscale Analysis and Methods for Quantum and Kinetic Problems
30 January–10 March 2023

Program webpage
https://ims.nus.edu.sg/events/qkp2023/

Registration
https://tinyurl.com/multiscaleanalysisreg

Photo by eberhard-gross gasteiger on Unsplash

Contact information
Institute for Mathematical Sciences
National University of Singapore
3 Prince George's Park Singapore 118402
ims.nus.edu.sg