HAUSDORFF SCHOOL
FOR ADVANCED STUDIES
IN MATHEMATICS

UNIVERSITÄT BONN

Workshop

"Young Women in Mathematical Biology"

April 1-3, 2025

organized by
Eugenia Franco, Anna Logioti

Abstracts

Marie Doumic Jauffret (INRIA and Ecole Polytechnique)

Asymptotic analysis and estimation problems in population dynamics

Abstract: The aim of this course is to present asymptotic direct and inverse problems coming from modelling biological populations. We first give a general overview of the models, their mathematical analysis and their application domains, detailing the correspondence between the population view, described by a Partial Differential Equation (PDE), and the underlying stochastic branching tree, as well as the scaling limits between the models. We then focus on the inverse problems consisting in the estimation of the initial distribution of the population and of the birth and death characteristics, as well as the choice of a "best-fit" model, for two types of applications: polymer breakage and cell division cycle.

Vivi Rottschäfer (Leiden University)

First lecture: Modelling drug dynamics in the brain, Second lecture: Can you always determine parameters from data in a unique way?

Abstract: Many drugs need to bind to receptors in the brain to have an effect. In this talk, I will present various models that we developed to study drug distribution into the brain and the central nervous system (CNS). In these models we take the physiology of the CNS and the pharmacokinetic properties of the drugs into account. We developed a compartmental model as well as a spatial model for drug distribution into the brain. We compare the results of the models to results of experiments (in rats). The future aim is to use the compartmental model for prediction of drug concentrations in the brain and their resulting effect in case no experimental data is available for a drug. In the second part of the talk, I will consider the question of whether parameters in a mathematical model can be determined *uniquely* from available data. This is often overlooked when models are analysed and simulated. I will give a brief overview of some of the available methods to determine parameters in a model *uniquely*.

Mariya Ptashnyk (Heriot-Watt University Edinburgh)

From individual cells to tissues: multiscale modelling, analysis and simulation of chemical and mechanical interactions in biological tissues.

Abstract: In this minicourse we will consider multiscale modelling, analysis and simulation of mechanical and chemical interactions between cells. In the microscopic models the biological processes will be defined on the level of a single cell. Using multiscale analysis techniques, we will derive macroscopic tissue level description of intercellular signalling in and growth of biological tissues. Techniques of nonlinear analysis are applied to analyse the microscopic models and rigorously derived the macroscopic effective equations in the limit of many cells. The two-scale (bulk-surface) finite element method is used for the approximation and numerical simulation of the macroscopic models. As specific examples we will discuss intercellular signalling processes involving receptor movement on cell membranes, mechanical interactions and growth in multicellular systems, and stress-based growth of plant tissues.