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DISMA Dipartimento di Scienze Matematiche G. L. Lagrange

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Seminario on-line

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Two Models of Adaptive Dynamics of Structured Populations: Analysis and Simulation

Prof. Lorenzi introduces the seminar.

Abstract

Structured population models offer us a powerful way of studying the adaptive dynamics of some hidden characteristics, or "traits", which are different from individual to individual. In this talk, Dr Ruan will introduce two types of recently studied models, namely the age-structured models and the structured cell growth model with heterogeneous mobility and proliferation rate.

In the age-structured models, Dirac concentrations on particular phenotypical traits appear in the case without mutation, which makes the numerical resolution of the problem challenging. Dr Ruan will briefly review the asymptotic results of the model and further design an asymptotic preserving (A-P) scheme based on the WKB ansatz of the solutions. With the method, we can accurately capture the concentrations on a coarse, parameter-independent mesh. Important properties, including the A-P property, are rigorously proved. The scheme can be generalized to the case with mutation, where a nonlinear Hamilton-Jacobi equation will be involved in the limiting model. It can be formally shown that the generalized scheme is A-P as well.

In the second model, we study the dynamics of a growing population of cells with heterogeneous mobility and proliferation rate. Specifically, we consider the case where the more mobile cells are less proliferative and vice versa. An implicit finite volume scheme is designed and proved with several nice properties. In particular, we found via simulation that, in the case where mobility is bounded, compactly supported traveling fronts emerge, while the stretching fronts may occur in the case where mobility is unbounded. Formal asymptotic analysis will be presented to explain the numerical results.

Biography

Xinran RUAN is a postdoc fellow in LJLL, Sorbonne Université. He received his B.S. degree from Peking University in 2012 and the PhD degree from the National University of Singapore in 2017.

He is a young researcher in applied math, focusing on scientific computing and numerical analysis. He has been working on PDE models arising in quantum physics and PIDE models arising in mathematical biology. Specifically, he has worked on numerical methods to compute the ground states of nonlinear Schrödinger equations modelling Bose-Einstein condensates and asymptotic-preserving schemes for capturing concentration phenomena in PIDEs modelling evolutionary dynamics in structured populations.