On Chemical and Biochemical Reaction-Diffusion Systems: Quasi-steady-state approximation and Large time behaviour

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This talk is about volume-surface reaction-diffusion systems modelling asymmetric stem cells division and reaction-diffusion systems modelling chemical reaction networks.

During asymmetric stem cell division, the asymmetric localisation of certain proteins called cell-fate determinants leads to two different daughter cells. The localisation those proteins are observed in Drosophila SOP cells to obey two significant processes: diffusion (both in cell cytoplasm and cell membrane) and biochemical reaction. We propose and study a volume-surface reaction-diffusion system capturing the mentioned processes. In particular, we study the quasi-steady-state approximation of the system when some reaction rate constants are much bigger than the other rates.

The biochemical reaction dynamic studied in the first part is a special case of chemical reaction network theory. The large time behavior for a large class of reaction networks is shown in the second part of the talk using entropy method. First, we propose a constructive method to prove the convergence to equilibrium with computable rates for detailed balance systems. Then we show the applicability of the entropy method to networks without detailed balance condition in the example of first-order networks.