Progress in 'Chemical Reaction Network Theory'

Organizers: Carsten Wiuf (*University of Copenhagen, DK)*, Elisenda Feliu (*University of Copenhagen, DK)*

Monday, July 2, 17:15–19:15, Medium Hall B

Talks:

Casian Pantea (*Imperial College, London, UK*), Coauthors: Gheorghe Craciun, Fedor Nazarov, **The global attractor conjecture and the Persistence Conjecture in mass-action systems**

Elisenda Feliu (*University of Copenhagen, DK*), **Qualitative inference on switch-like behaviour in networks of interacting species**

Murad Banaji (*University of Portsmouth, UK*), **From convex geometry to stability in chemical reaction networks**

Mirela Domijan (*University of Warwick, UK*), **Some observations on interaction graphs of mass-action reaction networks**

The global attractor conjecture and the Persistence Conjecture in mass-action systems

Casian Pantea
Imperial College, London, UK

Mass-action systems are a large class of nonlinear differential equations, widely used in the modelling of interaction networks in chemistry and biology. The study of qualitative properties of such systems, like the existence of multiple steady states, stability properties of equilibria, or persistence (non-extinction) of variables, is a very active area of research, generally termed "chemical reaction network theory". In this work I will discuss two long-standing conjectures in this field, and some partial recent results aimed at their resolution. This is joint work with Gheorghe Craciun and Fedor Nazarov.

Coauthors: Gheorghe Craciun, Fedor Nazarov

Qualitative inference on switch-like behaviour in networks of interacting species

Elisenda Feliu
University of Copenhagen, DK

Qualitative inference aims to infer properties of models with a common underlying structure. Here, we study a general framework for qualitative inference in systems of interacting species and develop a criterion to assess whether such a system has the capacity for multiple positive non-degenerate steady states. An interaction network is modelled as a system of ordinary differential equations in which the form of the species formation rate function is restricted by the reactions of the network and how the species influence each reaction. We characterize sets of interaction networks for which any choice of associated species formation rate function is injective within each stoichiometric class and thus cannot exhibit multistationarity. Our criteria rely on the determinant of the Jacobian of the species formation rate functions that belong to the class of so-called general mass-action kinetics. The criteria are computationally tractable and easily implemented.

From convex geometry to stability in chemical reaction networks

Murad Banaji
University of Portsmouth, UK

We focus on applications of the theory of monotone dynamical systems to questions of local and global stability of equilibria in chemical reaction networks (CRNs). It is shown that monotonicity and strong monotonicity can be structural features of a chemical reaction system, largely independent of the choice of reaction kinetics. However, identifying such "structurally order preserving" CRNs can be nontrivial. Moreover the dynamical consequences of order preservation depend on the geometrical relationships between order cones and invariant subspaces: in some cases monotonicity implies local or even global stability of equilibria. Examples of families of CRNs, which can be shown to have such behaviour, are presented.

Some observations on interaction graphs of mass-action reaction networks

Mirela Domijan
University of Warwick, UK

Recently, there has beenăgrowing interest in using graphical methods to analyse behaviour of reaction networks that areădescribed by systems of ordinary differential equations (ODEs).ăGraphs have an enviable advantage that they can be used to study systems of large size and with parameter uncertainty. In this talk,ălăwill present our results connecting system dynamics to structures of the interaction graph (a graph that is defined by the signs of the Jacobian matrix entries). I will also show how these results fit in the context of Chemical Reaction Network Theory.