Two talks on Chemical Reaction Network Theory

Chemical reaction networks (CRNs) are commonly modelled using nonlinear differential equations. Such models are almost universally complicated by parameter uncertainty. However, the dynamical properties of large classes of CRN models are remarkably robust to changes in parameter values, leading to a range of results relating network structure to dynamical behaviour. Such parameter-free approaches to the analysis of CRNs fall broadly into the scope of chemical reaction network theory*, a body of work started by F. Horn, R. Jackson and M. Feinberg fourty years ago. Fuelled in part by the advent of systems biology, chemical reaction network theory has experienced a surge of interest in recent years.*

The Department of Mathematics is happy to host two chemical reaction network theory experts this coming week.

Tuesday Nov 19, 2:30PM in **Armstrong Hall 315**

Maya Mincheva

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Dynamic instabilities of biochemical reaction networks

Interactions of complex networks of genes, proteins and enzymes play a central role in modern cellular biology. The talk will focus on mathematical models for biochemical reaction networks, which are usually modeled as large systems of coupled nonlinear differential equations with many unknown parameters. First we will give overview of the history of the problem. Then we will describe current efforts to relate the dynamic behavior of the differential equations models to the topology of the corresponding biochemical networks. Examples of models of multistability, oscillations and Turing instability (pattern formation) will be given.

Thursday Nov 21, 3:30PM in **Armstrong Hall 315**

Stefan Müller

Johann Radon Institute for Computational and Applied Mathematics (RICAM)
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Sign conditions for injectivity and surjectivity of generalized polynomial maps

We characterize the injectivity of families of generalized polynomial maps in terms of sign vectors. The term"generalized" indicates that we allow polynomials with real exponents, which define maps on the positive orthant. Our work relates to and extends existing injectivity conditions expressed in terms of determinants. Moreover, we provide sign conditions for surjectivity which allow a generalization of Birch's theorem. As an application, we give conditions for precluding multiple steady states in chemical reaction networks with power-law kinetics, for precluding multiple "special" steady states, for guaranteeing two distinct special steady states in some compatibility class for some rate constants, and, finally, for existence and uniqueness of special steady states in every compatibility class for all rate constants.