Fritz-Haber-Institut der Max-Planck-Gesellschaft, Humboldt-Universität zu Berlin, Max-Delbrück-Centrum für Molekulare Medizin, Otto-von-Guericke-Universität Magdeburg, Physikalisch-Technische Bundesanstalt, Technische Universität Berlin, Universität Potsdam

Berlin Center for Studies of Complex Chemical Systems

Seminar

Complex Nonlinear Processes in Chemistry and Biology

Honorary Chairman: G. Ertl
Organizers: M. Bär, C. Beta, H. Engel, M. Falcke, M. J. B. Hauser, J. Kurths, A. S. Mikhailov, P. Plath, L. Schimansky-Geier, and H. Stark

Friday, January 22, 2016, at 16:00
Address: Richard-Willstätter-Haus, Faradayweg 10, 14195 Berlin, U-Bahnhof Thielplatz (U3)

Dr. Annette F. Taylor
Chemical and Biological Engineering, University of Sheffield, UK

Feedback and Collective behaviour in Enzyme-Loaded Beads

Many single-celled organisms, such as yeast, bacteria and slime mould show complex dynamics driven by a combination of an autocatalytic signal and an intercellular communication mechanism. The presence of autocatalysis ensures the possibility for a response above a threshold signal; it also provides a mechanism by which behaviour can be rapidly synchronised across a population. Population-wide switches and synchronisation of activity are used by cellular organisms to deliver coordinated pulses of chemicals, initiate motion and material formation.

Here I will discuss our efforts in the design of bio-inspired complex dynamics in compartmentalised autocatalytic reactions in experiments and in simulations. Some time ago, it was suggested that feedback might be obtained in enzyme catalysed reactions in non-buffered environments as a result of the bell-shaped rate-pH curve. A small number of enzyme-catalysed reactions have been shown to display feedback via this route, including the urease catalysed hydrolysis of urea. We will show how bistability, switches and oscillations is obtained in urease-loaded beads and the potential role of differential transport will be examined. Collective behaviour displayed by populations of particles including synchronisation and dynamical quorum sensing (a density dependent transition to population-wide oscillations) will also be discussed. The compartmentalisation of synthetic autocatalytic reactions may provide insights into dynamic behaviour in cellular systems as well as new methods for drug delivery, sensing and repair that may be exploited in living systems.

Taylor, A. F. et al., Phys. Chem. Chem. Phys **17**, 20047 (2015)

Wrobel M. M. et al., Biophys. J. **103**, 610 (2012)

Bansagi, Jr. et al., J. Phys. Chem. B **118**, 6092 (2014)

Muzika F et al., Chem. Comm. **50**, 11107 (2014)