Construction the model of Belousov-Zhabotinsky reaction by means of the state trajectory creation

Anna Zhyrova, Tomáš Náhlík, Petr Císař and Dalibor Štys

School of Complex Systems, Faculty of Fisheries and Protection of Waters, University of South Bohemia, Zámek 136, 373 33 Nové Hrady, Czech Republic

zhyrova@frov.jcu.cz

Abstract

The Belousov- Zhabotinsky reaction is used as example of self-organising system which is easily and intelligibly observable and experimentally accessible. As in many natural self-organising systems its performance is dependent on combination of chemical and mechanical factors. Unlikely, for example, living cells, the self-organisation in the Belousov-Zhabotinsky reaction (as well as in other chemical clocks) is expressed macroscopically and in two dimensions. When performed in a thin – few centimeters thick – layer, it creates easily observable travelling waves which may be captured by ordinary colour camera and analysed. The analysis does not require elaborate reconstruction of series of 3D images as in the case of bird flocks or fish schools or organ behavior. The analysis of living cells microscopic image series is even more elaborate. Moreover, the experimenter in case of chemical clock has full control of mechanical constraints imposed on the system.

In this contributions are reported both experimental and theoretical results using the Belousov-Zhabotinsky reaction as experimental tool for analysis of the behavior of the self – organising system. The general goal of the work is to collect data which would allow us to compare it with an available simplified model of the reaction. There are a few models, neither of them predicts the experimentally detectable behavior. This is always composed of observed sequence of states stable for certain period of time. The sequence of states is regular, the time of transitions between the states as well as concrete shape of travelling waves is sensitively dependent on initial conditions.

We have performed a representative series of analyses in several different geometries and created a state trajectory using several selected image identifiers (point information gain entropy density – PIE/points) [1, 2]. The PIE/point values define an approximative state space which may be analysed using multivariate analysis. In this paper we provide results of this analysis. We show how the multivariate analysis may be used for construction of tentative model and possible variables and coordinates in the internal phase space of the system. States in the course of the reaction may be identified in all cases when the geometry of the experimental vessel allows creation of travelling waves. The identification of the internal coordinate system is still matter of experimentation and development and the state of the art is critically reported.

References:

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