Diffusion Influence on Phase Synchronization in the Glycolytic Reaction in a Distributed Medium

D.V. Verveyko, A.Yu. Verisokin
Theoretical Physics Department, Kursk State University
allegroform@mail.ru, ffalconn@mail.ru

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We study the synchronization process during the glycolytic reaction in a distributed medium. We base on Selkov model [1] extended with diffusion:

$$\begin{aligned} \dot{x} &= \nu - xy^2 + D_1 \nabla^2 x, \\ \dot{y} &= xy^2 - wy + D_2 \nabla^2 y. \end{aligned} \tag{1}$$

The distributed Selkov system is considered in a one-dimensional case, i.e. we assume that reaction occurs in a homogeneous medium inside a long tube impermeable at end faces. The linear analysis shows that the simplest solution with divergent oscillations is both synchronous oscillations along the tube and a cosine wave.

For the numerical analysis of synchronization processes we use the following values of parameters corresponding to relaxation regime: $\nu = 2.55$, $w = 2$. The space of a tube was shared on 1024 nodes ("generators") in such a way that each small volume in the space represents a point oscillator. The initial values for the nodes correspond to the values taken from the limit cycle of the local Selkov system presented in the modified Rayleigh form [2] with linear growth of a phase angle.

Using the continuous wavelet transform it was shown that there exist various patterns for different diffusion coefficients: from the birth of a hierarchy of phase clusters to their complete phase synchronization. The emergence of spatial phase clusters occurs at equal diffusion coefficients and is connected with various local rotation velocities in phase space, so these structures are not the Turing ones. Large diffusion coefficients stabilize process while small diffusion provides an asynchronous regime only.

References

[1] E.E. Selkov, *Self-oscillations in glycolysis. I. A simple kinetic model*, Eur. J. Biochem. **4** 79–86, 1968.

[2] .I. Lavrova, L. Schimansky-Geier, E.B. Postnikov, *Phase reversal in the Selkov model with inhomogeneous inlux*, Phys. Rev. E **79** 057102, 2009.