**2018. február 15.**

Drexler Dániel (Óbudai Egyetem):
A rák megszelídítése irányításelméleti módszerekkel

**2018. február 22.**

Tóth János:

Oszcilláció két anyagfajtát tartalmazó reakciókban

(Történeti áttekintés és előkészítés)

**2018. március 1.**

Nagy Ilona:

Két határciklus létezésének egzakt bizonyítása egy két anyagfajtát tartalmazó rendszerben (Előkészületben lévő cikk eredményeinek és módszereinek ismertetése)

**2018. március 22.**

**Gábor Szederkényi**: Computation of chemical reaction network structures with given properties

**Abstract**: Kinetic systems form a general class of nonlinear dynamical models that is suitable to describe complex nonlinear phenomena not only in (bio)chemical processes but in other fields as well, where the state variables are constrained to be nonnegative [1]. A dynamical model given in the form of ODEs is kinetic if a weighted directed graph (i.e., a chemical reaction network) can be assigned to it, which realizes the dynamics. Necessary and sufficient conditions for the kinetic property of a polynomial ODE were given in [2] and it is known that the reaction graph corresponding to a given dynamics is non-unique. However, in chemical reaction network theory, strong results have been developed on the relations between network structure and the dynamical properties (stability, existence/uniqueness of equilibria, boundedness of solutions etc.) of the system. Therefore, it is of interest to study if there exist such network structures/parametrizations for a set of kinetic ODEs that guarantee a desired property. In this lecture, a summary of computational methods will be presented based on [3-6] that can be used to study the existence and compute reaction graphs with preferred properties such as minimal/zero deficiency, complex/detailed balance or weak reversibility.

**References:**

[1] P Érdi, J Tóth. Mathematical models of chemical reactions: Theory and applications of deterministic and stochastic models. Manchester University Press, Princeton Univ. Press, 1989

[2] Hárs, V.; Tóth, J.: On the inverse problem of reaction kinetics, In: Colloquia Mathematica Societatis János Bolyai, (Szeged, Hungary, 1979) Qualitative Theory of Differential Equations (M. Farkas ed.), 30 North-Holland - János Bolyai Mathematical Society, Budapest, 1981, pp. 363-379.
<http://www.math.bme.hu/~jtoth/pubtexts/SzegedInverse.pdf>

[3] Szederkényi G, Hangos K M. Finding complex balanced and detailed balanced realizations of chemical reaction networks. JOURNAL OF MATHEMATICAL CHEMISTRY 49: pp. 1163-1179. (2011)
<http://dx.doi.org/10.1007/s10910-011-9804-9>

[4] Johnston M D , Siegel D, Szederkényi G. Computing weakly reversible linearly conjugate chemical reaction networks with minimal deficiency. MATHEMATICAL BIOSCIENCES 241:(1) pp. 88-98. (2013)
<http://dx.doi.org/10.1016/j.mbs.2012.09.008>

[5] Lipták G, Szederkényi G, Hangos KM. Computing zero deficiency realizations of kinetic systems. SYSTEMS & CONTROL LETTERS 81: pp. 24-30. (2015)
<http://dx.doi.org/10.1016/j.sysconle.2015.05.001>

[6] Ács B, Szederkényi G, Tuza Zs, Tuza A A. Computing all possible graph structures describing linearly conjugate realizations of kinetic systems. COMPUTER PHYSICS COMMUNICATIONS 204: pp. 11-20. (2016)
<http://dx.doi.org/10.1016/j.cpc.2016.02.020>

**2018. március 29.**

**Balázs Boros:** The center problem for planar S-systems

**Abstract:** S-systems are simple examples of power-law dynamical systems (polynomial systems with real exponents).

We describe when exactly the unique positive equilibrium of a planar S-system is a local/global center. Further, we construct two limit cycles.

**Reference**: Section 3 in <https://arxiv.org/pdf/1707.02104.pdf>

**Keywords:** power-law system, first integral, reversible system, Erste/Zweite Strudelgröße, Andronov-Hopf bifurcation, Bautin bifurcation

**2018. szeptember 18.**

Report on (some lectures of) the conferences

Boros Balázs: SIAM Coference on Life Sciences

<https://www.siam.org/Conferences/CM/Main/ls18>

Tóth János: European Conference on Mathematical and Theoretical Biology

<http://www.ecmtb2018.org/>

**2018. szeptember 25.**

**1. Szederkényi Gábor:**

Approximating the domain of attraction of uncertain nonlinear systems using linear matrix inequalities and Finsler's lemma

Authors: Péter Polcz, Gábor Szederkényi, Tamás Péni

In this contribution, we consider locally asymptotically stable nonlinear autonomous models in ODE form, where the coordinates functions of the right hand side are rational functions of the differential variables and may contain constant uncertain parameters. It is assumed that the initial values and the uncertain parameters belong to known polytopes. The rational terms contained in the Lyapunov function are computed using the linear fractional representation (LFR), and the required properties of the Lyapunov function are given in the form of linear matrix inequalities. The domain of attraction (DOA) is approximated using the appropriate level sets of the computed Lyapunov function. To add further degrees of freedom to the computations, we use Finsler's lemma, which requires the determination of affine annihilators for the basis functions. To decrease the size of the resulting optimization problem without increasing the level of conservatism of the DOA estimation, we propose simplification algorithms for the LFR and for the annihilator. The operation of the method is shown on illustrative examples known from the literature.

[1] P. Polcz, T. Péni and G. Szederkényi. Improved algorithm for computing
the domain of attraction of rational nonlinear systems. European Journal
of Control, 39:53-67, 2018.
[2] P. Polcz, T. Péni and G. Szederkényi. Reduced linear fractional
representation of nonlinear systems for stability analysis. IFAC Papers
Online, 51:37-42, 2018.

**2.  Gáspár Vilmos:**

Beszámoló a 2018. évi "Oscillation and Dynamic Instabilities in Chemical Systems" című Gordon Research Konferenciáról

 Az előadás elején ismertetem az unikális jellegű "Gordon Research Conferences" eredettörténetét és az "oszcillációs" sorozat két évtizedes történetét, majd bemutatom és elemzem a konferencia résztvevőinek kapcsolati hálóját (small world). A szekciók áttekintésével megpróbáljuk "kitapogatni" a következő időszak érdekesebb témáit és a témakör fejlődési irányait.

**2018. október 2.**

**Regular behavior of three repressilator models**

János Tóth will talk about the joint work with Masa Dukaric, Hassan Errami, Roman Jerala, Tina Lebar, Valery G. Romanovski, Andreas Weber about the manuscript: <https://arxiv.org/abs/1809.08840>

One 3D and two 6D models (ODEs with rational right hand sides) of repressilators have been introduced. All the models have a single positive stationary point which is locally asymptotically

stable. This framework is quite routine but to prove the steps are far from being trivial: polynomial varieties are used to determine the existence and uniqueness of the stationary points. The calculations also needed the use of Mathematica, Singular and QeHopf.

The existence of the stationary points in all the three cases can also be proven in the following way. One transforms the right hand side into a polynomial without negative cross-effect, then constructs a reversible reaction which induces the given right hand side, therefore the existence follows. (In other words: we apply a result from reaction kinetics in mathematics.)

2. The above lecturer also promised to present reviews on conferences. Now these can be found (in Hungarian) here:

<http://www.ematlap.hu/index.php/hirek-ujdonsagok-2018-09/773-2018-a-matematikai-biologia-eve>

<http://www.ematlap.hu/index.php/gazda-g-sag-2018-09/774-30-eves-a-wolfram>

**2018. október 9.**

Gáspár Vilmos: Delayed Feedback Induced Multirhythmicity -  Experiments and Models

Occurrence of bi- and trirhythmicity (coexistence of two or three stable limit cycles, respectively, with distinctly different periods) has been studied experimentally by applying delayed feedback control to the copper-phosphoric acid electrochemical system oscillating close to a Hopf bifurcation point. With small delay times (tau) the period exhibits a sinusoidal type dependence on tau. However, with relatively large delays for each feedback gain K there exists a critical delay τcrit above which birhythmicity emerges. At very large delays, the dynamics becomes even more complex, and trirhythmicity could be observed. Results of numerical simulations based on a general kinetic model for metal electrodissolution were consistent with the experimental observations. The results are also interpreted by using a simple phase model.