
Dynamics of bipolar disorders model: periodic and switching phenomenon

Ilona Kosiuk^{*†1}, Peter Szmolyan², and Ekaterina Kutafina³

¹Max Planck Institute for Mathematics in the Sciences (MPI-MIS) – Inselstrasse 22, D-04103, Leipzig, Germany

²The Vienna University of Technology – Austria

³AGH University of Science and Technology – Poland

Abstract

Slow-fast dynamical systems are a prevalent class of singularly perturbed differential equations that appear in the modelling of many complex biological processes. In this talk an ODE system modeling oscillatory patterns of mood alternations in manic-depression, also known as bipolar disorder, is analyzed. The model is four-dimensional, contains many parameters of different orders of magnitude, and non-polynomial nonlinearities. Hence, the equations do not allow for a global split into slow and fast variables and a complete treatment of the model by means of singular perturbation arguments is not at all straightforward. In particular, identification of slow manifolds, which organize phase space becomes challenging. It turns out that to understand the global dynamics of this multi-parameter singular perturbation problem one needs to identify and use hierarchies of local approximations based on various — hidden — forms of time scale separation.

I will highlight the main concepts from geometric singular perturbation theory and geometric desingularization based on the blow-up method in combination with standard techniques from dynamical systems theory which I use to understand this intriguing switching phenomenon.

*Speaker

†Corresponding author: ilona.kosiuk@mis.mpg.de