

The Strong Unstable Manifold and Periodic Solutions in Differential Delay Equations with Cyclic Monotone Negative Feedback

Anatoli F. Ivanov, Bernhard Lani-Wayda

University of Pennsylvania, USA, and Justus-Liebig-Universität Gießen, Germany
BERNHARD.LANI-WAYDA@MATH.UNI-GIESSEN.DE

Abstract

For $(N+1)$ -dimensional systems of differential delay equations with cyclic and monotone negative feedback, we construct a two-dimensional invariant manifold, on which phase curves spiral outward towards a bounding periodic orbit. We assume essentially only instability of the zero equilibrium. Methods of the Poincaré-Bendixson theory due to Mallet-Paret and Sell are combined with techniques used by Walther for the scalar case ($N = 0$). Statements on the attractor location and on parameter borders concerning stability and oscillation are included. The results apply to models for gene regulatory systems, e.g. the ‘repressilator’ system.

References

- [1] Ivanov, A. F., and Lani-Wayda, B.: *The strong unstable manifold and periodic solutions in differential delay equations with cyclic monotone negative feedback*. Commun. Pure Appl. Anal. (CPAA) Vol. **24**, Iss. 9 (2025), 1713-1752. Doi: 10.3934/cpaa.2025057