Pulses in singularly perturbed reaction-diffusion systems

Veerman, F.W.J.

Author: Veerman, Frits
Title: Pulses in singularly perturbed reaction-diffusion systems
Issue Date: 2013-09-25

References

[1] NIST Digital Library of Mathematical Functions: Legendre and Related Functions. `http://dlmf.nist.gov/14`, 2012.

[2] The Wolfram Functions Site: Associated Legendre function of the first kind type 2. `http://functions.wolfram.com/HypergeometricFunctions/LegendreP2General/`, 2012.

[3] J. Alexander, R.A. Gardner, and C.K.R.T. Jones. A topological invariant arising in the stability analysis of traveling waves. 1990.

[4] W. Chen, D. Iron, J. Rumsey, and M.J. Ward. The stability and dynamics of two-spot patterns for a class of reaction-diffusion systems in $\mathbb{R}^2$. *In preparation*, 2012.

[5] W. Chen and M.J. Ward. Oscillatory instabilities of multi-spike patterns for the one-dimensional Gray-Scott model. *European Journal of Applied Mathematics*, 20(2):187 – 214, 2009.

[6] A. Doelman, R.A. Gardner, and T.J. Kaper. Large Stable Pulse Solutions in Reaction-diffusion Equations. *Indiana University Mathematics Journal*, 50:443 – 507, 2001.

[7] A. Doelman, R.A. Gardner, and T.J. Kaper. *A stability index analysis of 1-D patterns of the Gray-Scott model*, volume 155 of *Memoirs of the Americal Mathematical Society*. American Mathematical Society, 2002.

[8] A. Doelman, G.M. Hek, and N. Valkhoff. Algebraically decaying pulses in a Ginzburg-Landau system with a neutrally stable mode. *Nonlinearity*, 20(2):357 – 389, 2007.

[9] A. Doelman, D. Iron, and Y. Nishiura. Destabilization of fronts in a class of bi-stable systems. *SIAM Journal on Mathematical Analysis*, 35(6):1420–1450, 2004.

[10] A. Doelman and T.J. Kaper. Semi-strong pulse interactions in a class of coupled reaction-diffusion equations. *SIAM Journal on Applied Dynamical Systems*, 2(1):53 – 96, 2003.

[11] A. Doelman, T.J. Kaper, and R.A. Gardner. Stability analysis of singular patterns in the 1D Gray-Scott model: a matched asymptotics approach. *Physica D*, 122:1–36, 1998.

[12] A. Doelman, T.J. Kaper, and K. Promislow. Nonlinear asymptotic stability of the semi-strong pulse dynamics in a regularized Gierer-Meinhardt model. *SIAM Journal on Mathematical Analysis*, 38(6):1760 – 1787, 2007.

[13] A. Doelman, T.J. Kaper, and P.A. Zegeling. Pattern formation in the one-dimensional Gray-Scott model. *Nonlinearity*, 10(2):523 – 563, 1997.

[14] A. Doelman, J. Rademacher, and S. van der Stelt. Hopf dances near the tips of busse balloons. *Discrete and Continuous Dynamical Systems*, 5:61–92, 2012.

[15] A. Doelman and H. van der Ploeg. Homoclinic stripe patterns. *SIAM Journal on Applied Dynamical Systems*, 1(1):65 – 104, 2002.

[16] A. Doelman and F. Veerman. An explicit theory for pulses in two component, singularly perturbed, reaction-diffusion equations. *Journal of Dynamics and Differential Equations*, 2013.

[17] S. Ei. The motion of weakly-interacting pulses in reaction-diffusion systems. *Journal of Dynamics and Differential Equations*, 14:85–137, 2002.

[18] N. Fenichel. Persistence and smoothness of invariant manifolds for flows. *Indiana University Mathematics Journal*, 21:193–226, 1971.

[19] N. Fenichel. Geometrical singular perturbation theory for ordinary differential equations. *Journal of Differential Equations*, 31:53–98, 1979.

[20] R. Fitzhugh. Impulses and physiological states in theoretical models of nerve membrane. *Biophysical Journal*, 1:445–466, 1961.

[21] R.A. Gardner and C.K.R.T. Jones. Stability of travelling wave solutions of diffusive predator-prey systems. *Transactions of the American Mathematical Society*, 327(2):465–524, 1991.

[22] A. Gierer and H. Meinhardt. A theory of biological pattern formation. *Kybernetik*, 12:30–39, 1972.

[23] P. Gray and S.K. Scott. Autocatalytic reactions in the isothermal, continuous stirred tank reactor: isolas and other forms of multistability. *Chemical Engineering Science*, 38:29–43, 1983.

[24] M. Haragus and G. Iooss. *Local Bifurcations, Center Manifolds, and Normal Forms in Infinite-Dimensional Dynamical Systems*. Springer, 2011.

[25] H. Ikeda, Y. Nishiura, and H. Suzuki. Stability of traveling waves and a relation between the Evans function and the SLEP equation. *Journal für die reine und angewandte Mathematik*, 475:1–37, 1996.

[26] D. Iron, M.J. Ward, and J. Wei. The stability of spike solutions to the one-dimensional Gierer-Meinhardt model. *Physica D*, 150:25 – 62, 2001.

[27] D. Iron, J. Wei, and M. Winter. Stability analysis of Turing patterns generated by the Schnakenberg model. *Journal of Mathematical Biology*, 49:358–390, 2004.

[28] C.K.R.T. Jones. Stability of the travelling wave solution of the Fitzhugh-Nagumo system. *Transactions of the Americal Mathematical Society*, 286:431–469, 1984.

[29] C.K.R.T. Jones. Geometric Singular Perturbation Theory. In A. Dold and F. Takens, editors, *Dynamical Systems (Montecatini Terme, Italy, 1994)*, Lecture Notes in Mathematics, vol. 1609, pages 44–118. C.I.M.E., Springer, Berlin, 1995.

[30] T.J. Kaper. An Introduction to Geometric Methods and Dynamical Systems Theory for Singular Perturbation Problems. In J. Cronin and R.E. O'Malley Jr., editors, *Analyzing multiscale phenomena using singular perturbation methods*, Proceedings of Symposia in Applied Mathematics, vol. 56, pages 85–131. American Mathematical Society, 1999.

[31] T. Kolokolnikov, T. Erneux, and J. Wei. Mesa-type patterns in the one-dimensional Brusselator and their stability. *Physica D*, 214:63–77, 2006.

[32] T. Kolokolnikov, M.J. Ward, and J. Wei. The existence and stability of spike equilibria in the one-dimensional Gray-Scott model: the low feed rate regime. *Studies in Applied Mathematics*, 115(1):21 – 71, 2005.

[33] T. Kolokolnikov, M.J. Ward, and J. Wei. The existence and stability of spike equilibria in the one-dimensional Gray-Scott model: the pulse-splitting regime. *Physica D*, 202(3-4):258 – 293, 2005.

[34] T. Kolokolnikov, M.J. Ward, and J. Wei. Pulse-splitting for some reaction-diffusion systems in one-space dimension. *Studies in Applied Mathematics*, 114(2):115 – 165, 2005.

[35] T. Kolokolnikov, M.J. Ward, and J. Wei. Self-replication of mesa patterns in reaction-diffusion models. *Physica D*, 236(2):104–122, 2007.

[36] K. Kuznetsov. *Elements of Applied Bifurcation Theory*. Springer, 3rd edition, 2004.

[37] J.M. Lee, T. Hillen, and M.A. Lewis. Pattern formation in prey-taxis systems. *Journal of Biological Dynamics*, 3(6):551 – 573, 2009.

[38] K.-J. Lin, W.D. McCormick, J.E. Pearson, and H.L. Swinney. Experimental observation of self-replicating spots in a reaction-diffusion system. *Nature*, 369:215 – 218, 1994.

[39] K. Morimoto. Construction of multi-peak solutions to the Gierer-Meinhardt system with saturation and source term. *Nonlinear Analysis*, 71:2532–2557, 2009.

[40] J. Nagumo, S. Arimoto, and S. Yoshizawa. An active pulse transmission line simulating nerve axon. *Proceedings of the IRE*, 50:2061–2070, 1962.

[41] Y. Nishiura and D. Ueyama. A skeleton structure of self-replicating dynamics. *Physica D*, 130:73 – 104, 1999.

[42] Y. Nishiura and D. Ueyama. Spatio-temporal chaos for the Gray-Scott model. *Physica D*, 150:137 – 162, 2001.

[43] J.E. Pearson. Complex patterns in a simple system. *Science*, 261:189–192, 1993.

[44] K. Promislow. A renormalization method for modulational stability of quasi-steady patterns in dispersive systems. *SIAM Journal on Mathematical Analysis*, 33(6):1455–1482, 2002.

[45] B. Sandstede. Stability of travelling waves. In B. Fiedler, editor, *Handbook of Dynamical Systems,*, volume II, pages 983 – 1055. Elsevier, 2002.

[46] J. Schnakenberg. Simple chemical reaction systems with limit cycle behavior. *Journal of Theoretical Biology*, 81:389 – 400, 1979.

[47] W. Sun, M.J. Ward, and R. Russell. The slow dynamics of two-spike solutions for the Gray-Scott and Gierer-Meinhardt systems: competition and oscillatory instabilities. *SIAM Journal on Applied Dynamical Systems*, 4(4):904 – 953, 2005.

[48] I. Takagi. Point-condensation for a reaction-diffusion system. *Journal of Differential Equations*, 61:208 – 249, 1986.

[49] E.C. Titchmarsh. *Eigenfunction Expansions Associated with Second-order Differential Equations*. 1962.

[50] A.M. Turing. The chemical basis of morphogenesis. *Philosophical Transactions of the Royal Society of London*, 237:37–72, 1952.

[51] H. van der Ploeg and A. Doelman. Stability of spatially periodic pulse patterns in a class of singularly perturbed reaction-diffusion equations. *Indiana University Mathematics Journal*, 54(5):1219 – 1301, 2005.

[52] S. van der Stelt, A. Doelman, G.M. Hek, and J. Rademacher. Rise and fall of periodic patterns for a generalized Klausmeier-Gray-Scott model. *Journal of Nonlinear Science*, 23(1):39 – 95, 2013.

[53] P. van Heijster, A. Doelman, T.J. Kaper, and K. Promislow. Front interactions in a three-component system. *SIAM Journal on Applied Dynamical Systems*, 9(2):292–332, 2010.

[54] F. Veerman and A. Doelman. Pulses in a Gierer-Meinhardt equation with a slow nonlinearity. *SIAM Journal on Applied Dynamical Systems*, 12(1):28–60, 2013.

[55] F. Verhulst. *Nonlinear Differential Equations and Dynamical Systems*. Springer, 2nd edition, 1996.

[56] M.J. Ward and J. Wei. The existence and stability of asymmetric spike patterns in the Schnakenberg model. *Studies in Applied Mathematics*, 109:229 – 264, 2002.

[57] M.J. Ward and J. Wei. Hopf bifurcation and oscillatory instabilities of spike solutions for the one-dimensional Gierer-Meinhardt model. *Journal of Nonlinear Science*, 13:209–264, 2003.

[58] J. Wei. Existence, stability and metastability of point condensation patterns generated by the Gray-Scott system. *Nonlinearity*, 12:593 – 616, 1999.

[59] J. Wei and M. Winter. On the Gierer-Meinhardt equation with saturation. *Communications in Contemporary Mathematics*, 6(2):259–277, 2004.