Abstract

(Farazmand and Haller 2012)

Sammendrag

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References

Adams, R. and Essex, C. (2010). *Calculus: A Complete Course.* 7th ed. Pearson, Toronto. ISBN: 978-0-321-54928-0.

Ali, S. and Shah, M. (2007). "A Lagrangian Particle Dynamics Approach for Crowd Flow Segmentation and Stability Analysis". In: *2007 IEEE Conference on Computer Vision and Pattern Recognition*, pp. 1–6. ISSN: 1063-6919.

Bogacki, P. and Shampine, L. (1989). "A 3(2) Pair of Runge-Kutta Formulas". In: *Applied Mathematics Letters* 2.4, pp. 321–325. ISSN: 0893-9659.

Bogacki, P. and Shampine, L. (1996). "An Efficient Runge-Kutta (4, 5) Pair". In: *Computers & Mathematics with Applications* 32.6, pp. 15–28. ISSN: 0898-1221.

Cargill, M. and O'Connor, P. (2013). *Writing Scientific Research Articles: Strategy and Steps.* 2nd ed. John Wiley & Sons. ISBN: 9781118570708.

Dormand, J., Lockyer, M., et al. (1989). "Global error estimation with Runge-Kutta triplets". In: *Computers and Mathematics with Applications* 18.9, pp. 836–846.

Dormand, J. and Prince, P. (1980). "A family of embedded Runge-Kutta formulae". In: *Journal of Computational and Applied Mathematics* 6.1, pp. 19–26. ISSN: 0377-0427.

Dormand, J. and Prince, P. (1986). "A reconsideration of some embedded Runge-Kutta formulae". In: *Journal of Computational and Applied Mathematics* 15.2, 203–211. ISSN: 0377-0427.

Farazmand, M. and Haller, G. (2011). "Erratum and addendum to 'A variational theory of hyperbolic Lagrangian coherent structures' [Physica D 240 (2011) 547–598]". In: *Physica D: Nonlinear Phenomena* 241.4, pp. 439–441. ISSN: 0167-2789.

Farazmand, M. and Haller, G. (2012). "Computing Lagrangian coherent structures from their variational theory". In: *Chaos: An Interdisciplinary Journal of Nonlinear Science* 22.1, p. 013128. ISSN: 1054-1500.

Fehlberg, E. (1974). *Classical fifth-, sixth-, seventh- and eighth order Runge-Kutta formulas with stepsize control.* Tech. rep. NASA-TR-R-432. NASA Marshall Space Flight Center, Huntsville, AL, United States.

Gough, M. K. et al. (2017). "Persistent Lagrangian transport patterns in the northwestern Gulf of Mexico". Unpublished. Preprint available at https://arxiv.org/abs/1710.04027 (retrieved December 19, 2017).

Hairer, E., Nørsett, S. P., and Wanner, G. (1993). *Solving Ordinary Differential Equations I: Nonstiff Problems.* 2nd ed. Springer-Verlag Berlin Heidelberg. ISBN: 978-3-540-56670-0. Corrected 3rd printing, 2008.

Hairer, E. and Wanner, G. (1996). *Solving Ordinary Differential Equations II: Stiff and Differential-Algebraic Problems.* 2nd ed. Springer-Verlag Berlin Heidelberg. ISBN: 978-3-642-05221-7. Corrected 2nd printing, 2002.

Haller, G. and Yuan, G. (2000). "Lagrangian coherent structures and mixing in two-dimensional turbulence". In: *Physica D: Nonlinear Phenomena* 147.3, pp. 352–370. ISSN: 0167-2789.

Haller, G. (2010). "A variational theory of hyperbolic Lagrangian Coherent Structures". In: *Physica D: Nonlinear Phenomena* 240.7, pp. 547–598. ISSN: 0167-2789.

Haller, G. (2015). "Lagrangian coherent structures". In: *Annual Review of Fluid Mechanics* 47, pp. 137–162.

Institute of Electrical and Electronics Engineers (2008). "IEEE Standard for Floating-Point Arithmetic". In: *IEEE Std 754-2008*, pp. 1–70. ɪsʙɴ: 978-0-7381-5752-8.

Lekien, F. and Ross, S. D. (2010). "The computation of finite-time Lyapunov exponents on unstructured meshes and for non-Euclidean manifolds". In: *Chaos: An Interdisciplinary Journal of Nonlinear Science* 20.1. ɪssɴ: 1054-1500.

Olascoaga, M. et al. (2008). "Tracing the early development of harmful algal blooms on the West Florida Shelf with the aid of Lagrangian coherent structures". In: *Journal of Geophysical Research: Oceans* 113.C12. ɪssɴ: 0148-0227.

Onu, K., Huhn, F., and Haller, G. (2015). "LCS Tool: A computational platform for Lagrangian coherent structures". In: *Journal of Computational Science* 7, pp. 26–36. ɪssɴ: 1877-7503.

Peacock, T. and Haller, G. (2013). "Lagrangian coherent structures: The hidden skeleton of fluid flows". In: *Physics Today* 66.2, p. 41.

Prince, P. and Dormand, J. (1981). "High order embedded Runge-Kutta formulae". In: *Journal of Computational and Applied Mathematics* 7.1, pp. 67–75. ɪssɴ: 0377-0427.

Shadden, S. C., Lekien, F., and Marsden, J. E. (2005). "Definition and properties of Lagrangian coherent structures from finite-time Lyapunov exponents in two-dimensional aperiodic flows". In: *Physica D: Nonlinear Phenomena* 212.3, pp. 271–304. ɪssɴ: 0167-2789.

Strogatz, S. H. (2014). *Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering*. Westview press, Colorado. ɪsʙɴ: 978-0-813-34910-7.

van Sebille, E. et al. (2018). "Lagrangian ocean analysis: Fundamentals and practices". In: *Ocean Modelling* 121, pp. 47–75. ɪssɴ: 1463-5003.

A Appendix A