

# Renato Huzak

## Address

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## Education

- Ph.D.: Jan 2010-Oct 2013, Dept of Math, Hasselt University, Belgium
- Master: Oct 2003-Feb 2008, Dept of Math, University of Zagreb, Croatia

## Professional Experience

- 2021-: Associate Professor, Dept of Math, Hasselt University, Belgium
- 2016-2021: Assistant Professor, Dept of Math, Hasselt University, Belgium
- 2015-2016: Postdoctoral Researcher, Dept of Math, York University, Toronto, Canada
- 2014-2015: Postdoctoral Researcher, Dept of Math, Hasselt University, Belgium

## Short Term Visits

University of Groningen, The Netherlands; University of Zagreb, Croatia; York University, Toronto, Canada; Plymouth University, England; Institute of Mathematics, Hanoi, Vietnam; TU Dresden, Germany; School of Mathematics and Maxwell Institute of Mathematical Sciences, University of Edinburgh, United Kingdom

## Publications

1. R. Huzak, P. De Maesschalck, F. Dumortier, *Limit cycles in slow-fast codimension 3 saddle and elliptic bifurcations*, J. Differ. Equations 255, No. 11, 4012–4051 (2013).
2. R. Huzak, P. De Maesschalck, F. Dumortier, *Primary birth of canard cycles in slow-fast codimension 3 elliptic bifurcations*, Commun. Pure Appl. Anal. 13, No. 6, 2641–2673 (2014).
3. R. Huzak, P. De Maesschalck. *Slow divergence integrals in generalized Liénard equations near centers*, Electron. J. Qual. Theory Differ. Equ. 2014, No. 66, 1–10.
4. P. De Maesschalck, R.Huzak. *Slow divergence integrals in classical Liénard equations near centers*, J. Dyn. Differ. Equations 27, No. 1, 177–185 (2015).
5. R. Huzak, *Cyclicity of the origin in slow-fast codimension 3 saddle and elliptic bifurcations*, Discrete Contin. Dyn. Syst. 36, No. 1, 171–215 (2016).
6. R. Huzak, *Normal forms of Liénard type for analytic unfoldings of nilpotent singularities*, Proc. Am. Math. Soc. 145(10), 4325–4336 (2017).
7. R. Huzak, *Regular and slow-fast codimension 4 saddle-node bifurcations*, J. Differ. Equations 262, No. 2, 1119–1154 (2017).
8. R. Huzak, *Cyclicity of degenerate graphic DF2a of Dumortier-Roussarie-Rousseau program*, Commun. Pure Appl. Anal. 17, No. 3, 1305–1316 (2018).
9. R. Huzak, *Box dimension and cyclicity of canard cycles*. Qual. Theory Dyn. Syst., 17 (2018), 475–493.
10. R. Huzak, *Predator-prey systems with small predator's death rate*, Electron. J. Qual. Theory Differ. Equ., 2018, No. 86, 1–16.
11. R. Huzak, D. Vlah. *Fractal analysis of canard cycles with two breaking parameters and applications*, Commun. Pure Appl. Anal. 18, No. 2, 959–975 (2019).
12. R. Huzak, *The slow divergence integral on a Möbius band*, J. Differ. Equations 266, No. 10, 6179–6203 (2019).
13. R. Huzak, *Quartic Liénard equations with linear damping*, Qual. Theory Dyn. Syst. 18, No. 2, 603–614 (2019).
14. R. Huzak, *Canard Explosion Near Non-Liénard Type Slow-Fast Hopf Point*, J. Dyn. Differ. Equations 31, No. 2, 683–709 (2019).
15. R. Huzak, *Finite cyclicity of the contact point in slow-fast integrable systems of Darboux type*, Electron. J. Differ. Equ. 2020, Paper No. 90, 15 p. (2020).

16. R. Huzak, V. Crnkovic, D. Vlah, *Fractal dimensions and two-dimensional slow-fast systems*, J. Math. Anal. Appl. 501, No. 2, Article ID 125212, 21 p. (2021).
17. R. Huzak, D. Rojas, *Period function of planar turning points*, Electron. J. Qual. Theory Differ. Equ. 2021, No. 16, 1–21.
18. L. Horvat Dmitrovic, R. Huzak, D. Vlah, V. Zupanovic, *Fractal analysis of planar nilpotent singularities and numerical applications*, J. Differ. Equations 293, 1–22 (2021).
19. P. De Maesschalck, R. Huzak, Y. Patsios, N. Popovic, *Jump-induced mixed-mode oscillations through piecewise-affine maps*, J. Math. Anal. Appl., 505, No. 1, Article ID 125641, 29 p. (2022).
20. R. Huzak, *Cyclicity of canard cycles with hyperbolic saddles located away from the critical curve*, J. Differ. Equations 320, 479–509 (2022).
21. R. Huzak, D. Rojas *Abelian Integrals and Non-generic Turning Points*, Qual. Theory Dyn. Syst. 21, No. 3, Paper No. 77, 18 p. (2022).
22. H. J. Kojakhmetov, R. Huzak, *Slow-fast torus knots*, Bull. Belg. Math. Soc. Simon Stevin 29 (2022), no. 3, 371–388.
23. J. Yao, R. Huzak, *Cyclicity of the Limit Periodic Sets for a Singularly Perturbed Leslie–Gower Predator–Prey Model with Prey Harvesting*, J Dyn Diff Equat (2022). <https://doi.org/10.1007/s10884-022-10242-2>
24. R. Huzak, D. Vlah, D. Zubrinic, V. Zupanovic, *Fractal analysis of degenerate spiral trajectories of a class of ordinary differential equations*, Appl. Math. Comput. 438, Article ID 127569, 15 p. (2023).
25. R. Huzak, K. Uldall Kristiansen, *The number of limit cycles for regularized piecewise polynomial systems is unbounded*, J. Differ. Equations 342, 34–62 (2023).
26. P. De Maesschalck, R. Huzak, A. Janssens, G. Radunovic, *Fractal codimension of nilpotent contact points in two-dimensional slow-fast systems*, J. Differ. Equations 355, 162–192 (2023).
27. V. Crnkovic, R. Huzak, M. Resman, *Fractal analysis of hyperbolic saddles with applications*, J. Math. Anal. Appl. (2023), 127662, doi: <https://doi.org/10.1016/j.jmaa.2023.127662>.
28. P. De Maesschalck, R. Huzak, A. Janssens, G. Radunovic, *Minkowski dimension and slow-fast polynomial Liénard equations near infinity*, Qual. Theory Dyn. Syst. 22, 154 (2023).
29. J. Yao, J. Huang, R. Huzak, *Cyclicity of slow-fast cycles with two canard mechanisms*, Chaos 34, 053112 (2024).
30. R. Huzak, K. Uldall Kristiansen, G. Radunovic, *Slow divergence integral in regularized piecewise smooth systems and applications*, Electron. J. Qual. Theory Differ. Equ. 2024, No. 15, 1–20.
31. R. Huzak, K. Uldall Kristiansen, *Sliding Cycles of Regularized Piecewise Linear Visible–Invisible Twofolds*, Qual. Theory Dyn. Syst. 23 (Suppl 1), 256 (2024).
32. J. Yao, J. Huang, R. Huzak, S. Ruan, *Cyclicity of slow-fast cycles with one self-intersection point and two nilpotent contact points*, accepted in Nonlinearity 2024
33. R. Huzak, P. Mardesic, M. Resman, V. Zupanovic, *Reading multiplicity in unfoldings from  $\epsilon$ -neighborhoods of orbits*, preprint
34. R. Huzak, H. J. Kojakhmetov, C. Kuehn, *Ergodicity in planar slow-fast systems through slow relation functions*, accepted in SIAM Journal on Applied Dynamical Systems, 2024.
35. J. Yao, J. Huang, R. Huzak, *Relaxation oscillations in predator-prey systems with piecewise smooth functional responses*, preprint
36. R. Huzak, A. Janssens, O. H. Perez, G. Radunovic, *Fractal analysis of canard cycles and slow-fast Hopf points in piecewise smooth Liénard equations*, preprint

### Talks

1. *Sliding cycles in regularized PWL visible-invisible twofolds*, Workshop Divergent series, slow-fast systems and piecewise linear systems, Sep 2 2024, Hasselt, Belgium
2. *Fractal Hilbert’s 16th problem and slow-fast Liénard equations*, Invited speaker, Dynamics Days Europe, Sep 3–8 2023, Naples, Italy
3. *A solution to fractal Hilbert’s 16th problem for slow-fast Liénard equations*, Invited speaker, Bifurcations of Dynamical Systems and Numerics WORKSHOP 2023, May 9–13, Zagreb, Croatia

4. *A new approach for detection of nonzero Lyapunov coefficients*, Seminar, University of Groningen, The Netherlands, 18 April 2023
5. *A new approach for detection of nonzero Lyapunov coefficients*, International Online GSDUAB Seminar, Barcelona, 6 March 2023
6. *Detection of the first nonzero Lyapunov quantity in degenerate slow-fast Hopf bifurcations from fractality of planar contact points*, Online Talk, 17 October 2022, Central China Normal University, Wuhan
7. *Detection of the first nonzero Lyapunov quantity in degenerate slow-fast Hopf bifurcations from fractality of planar contact points*, Talk, ICDEA 2022, 18–22 July 2022, Paris-Saclay, France
8. *Predator-prey slow-fast cycles and Hilbert’s 16th problem*, Talk, EQUADIFF, 11–15 July 2022, Brno, Czech Republic
9. *Fractal analysis of slow-fast systems*, Talk, Bifurcations of dynamical systems, Workshop, 9th–12th February, 2022, Zagreb, Croatia.
10. *Fractal dimensions and 2-dimensional slow-fast systems*, Talk, DynamicsDays2021, Nice, France, August 2021.
11. *Period function near planar turning points*, Talk, NoLineal 20-21 Online, Madrid, Spain, June 30-July 2, 2021.
12. *Period function near planar turning points*, Talk, SIAM Conference on Applications of Dynamical Systems (DS21), held virtually May 23-27, 2021.
13. *Slow-fast systems in dimensions 2 and 3*, Talk (Zoom platform), organized by Maja Resman, 4.11.2020, University of Zagreb, Croatia, <http://degiorgi.math.hr/kolokvij/view.php?id=172>
14. *Cyclicity of canard cycles with hyperbolic saddles located away from the slow curve*, Seminar, University of Edinburgh, UK, December 3-5, 2019
15. *Slow-fast Darboux systems*, Dynamics, Equations and Applications (DEA 2019), Invited speaker, Kraków, Poland, 16th to 20th September 2019
16. *Cyclicity of canard cycles with hyperbolic saddles located away from the slow curve*, Invited speaker, Advances in Qualitative Theory of Differential Equations, Castro Urdiales, Spain, June 17-21, 2019
17. *Slow-fast systems on a Möbius band*, Invited speaker, SIAM Conference on Applications of Dynamical Systems (DS19), Snowbird, Utah, May 19 - 23, 2019.
18. *The slow divergence integral on a Mobius band*, invited speaker, “Workshop on Algebraic and Analytical Methods for Dynamical Systems with Applications to Reaction Networks” organized by Sebastian Walcher, Aachen University, Germany, April 30, 2019.
19. *The slow divergence integral on a Mobius band and Quartic Liénard equations with linear damping*, Invited speaker, ZAGREB DYNAMICAL SYSTEMS WORKSHOP 2018, October 22–26, Zagreb, Croatia
20. *Slow-fast bifurcations and Hilbert’s 16th problem*, Invited speaker, SPT 2018, Cagliari, Italy, June 2018
21. *Box dimension and cyclicity of canard cycles*, University of Zagreb, Croatia, April 2018
22. *Normal forms of Liénard type, slow-fast bifurcations and fractal geometry of canard cycles*, Hasselt University, Belgium, November, 2017
23. *Normal forms of Liénard type, slow-fast bifurcations and fractal geometry of canard cycles*, University of Toulouse, France, November, 2017
24. *Regular and slow-fast codimension 4 saddle-node bifurcations*, EquaDiff 2017
25. *Regular and slow-fast codimension 4 saddle-node bifurcations*, University of Zagreb, Croatia, April 2017
26. *Slow-fast predator-prey systems*, Talk given at The Annual Meeting of the Canadian Society of Applied and Industrial Mathematics (CAIMS 2016), Edmonton, Alberta, Canada, June 26–30, 2016
27. *Codimension 4 saddle-node bifurcations*, Talk given at York University, November 15 – 28, 2015, Toronto, Canada
28. *Geometric singular perturbation theory and planar slow-fast systems*, Talk given at Institute of Mathematics, Hanoi, Vietnam, September 7–19, 2015
29. *Limit cycles in Liénard equations and blow-up techniques*, Talks given at Plymouth University, April 12 – May 1, 2015, Plymouth, England
30. *Slow-fast codimension 3 bifurcations*, Talk given at Fourth PhD-Day: Royal Academy, September 9, 2013, Brussel, Belgium

31. *Cyclicity of the origin in slow-fast codimension 3 bifurcations*, Talk given at Workshop on Slow-Fast Dynamics: Theory, Numerics, Application to Life and Earth Sciences, June 3 – June 7, 2013, Barcelona, Spain
32. *Limit cycles in slow-fast codimension 3 saddle and elliptic bifurcations*, Talk given at The 9th AIMS Conference on Dynamical Systems, Differential Equations and Applications, July 1 – 5, 2012, Orlando, Florida, USA
33. Poster with P. De Maesschalck and F. Dumortier on *Limit cycles in slow-fast codimension 3 saddle and elliptic bifurcations*, September 12 – 16, 2011, Castro Urdiales, Spain

**Promotor/co-promotor (PhD)**

1. Promotor of Yiorgos Patsios Aug 2022, “Geometry of jump-induced mixed-mode oscillations and topological horseshoes in three-dimensional slow-fast systems”
2. Co-promotor of Maikel Bosschaert Jan 2023, “Homoclinic solutions in finite and infinite dimensional systems”
3. Promotor of Vlatko Crnkovic joint PhD (in progress), Promotor of Ansfried Janssens (in progress), Promotor of Jinhui Yao, joint PhD (in progress), Co-promotor of Melvin Yeung (in progress), Co-promotor of Bram Lentjes (in progress)