

# 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

Technical University of Denmark; 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

## Promotor/co-promotor (PhD/postdoc)

1. Promotor of Yiorgos Patsios, “Geometry of jump-induced mixed-mode oscillations and topological horseshoes in three-dimensional slow-fast systems”, defended Aug 2022
2. Promotor of Jinhui Yao, “Cyclicity of slow-fast cycles and predator-prey systems”, defended May 2025
3. Promotor of Vlatko Crnkovic, “Fractal analysis of polycycles and foci in analytic and piecewise analytic systems”, defended July 2025
4. Co-promotor of Maikel Bosschaert Jan 2023, Co-promotor of Melvin Yeung Sep 2024
5. Promotor of Ansfried Janssens (in progress), Promotor of André Luis Martins Tomaz da Silva joint PhD (in progress), Co-promotor of Bram Lentjes (in progress)
6. Otavio H. Perez postdoc (May 2024–May 2025)

## Editor

Matemática Contemporânea

## 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*, 2024 Nonlinearity 37 115007.
33. R. Huzak, P. Mardesic, M. Resman, V. Zupanovic, *Reading multiplicity in unfoldings from  $\epsilon$ -neighborhoods of orbits*, Electronic Journal of Differential Equations, Vol. 2025 (2025), No. 61, pp. 1–19.

34. R. Huzak, H. J. Kojakhmetov, C. Kuehn, *Ergodicity in planar slow-fast systems through slow relation functions*, SIAM J. Appl. Dyn. Syst. 24, No. 1, 317-345 (2025).
35. J. Yao, J. Huang, R. Huzak, *Relaxation oscillations in predator-prey systems with piecewise smooth functional responses*, J. Differ. Equations, Volume 453 (4), 2026, 113907.
36. P. De Maesschalck, R. Huzak, O. H. Perez, *Canard cycles of non-linearly regularized piecewise smooth vector fields*, J. Differ. Equations 460 (2026) 114079
37. J. Huang, R. Huzak, O. H. Perez, J. Yao, *Cyclicity of sliding cycles with singularities of regularized piecewise smooth visible-invisible two-folds*, J. Differ. Equations 465 (2026) 114205.
38. R. Huzak, A. Janssens, O. H. Perez, G. Radunovic, *Fractal analysis of canard cycles and slow-fast Hopf points in piecewise smooth Lienard equations*, preprint
39. R. Huzak, G. Radunovic, V. Zupanovic, *Fractal analysis of slow-fast and regular systems in  $R^2$ : A survey of recent results and future perspectives*, preprint
40. R. Huzak, K. U. Kristiansen, On entry-exit formulas for degenerate turning point problems in planar slow-fast systems, preprint
41. R. Huzak, O. H. Perez, *An unbounded number of canard limit cycles in linear regularizations of piecewise linear systems*, preprint
42. J. Yao, J. Huang, R. Huzak, S. Ruan, *Limit cycles and global dynamics for a class of piecewise regular-singular systems*, preprint

### Talks

1. *Slow divergence integral in regularized PWS systems with sliding*, Invited speaker, XIV Workshop on Dynamical Systems FCT-UNESP, November 24 to 27, 2025, Presidente Prudente - SP, Brazil
2. *Hilbert's 16th problem for regularizations of piecewise polynomial systems*, Analysis & Geometry Seminar, UAntwerpen, Nov 5 2025.
3. *Sliding limit cycles in regularizations of piecewise smooth systems*, Invited speaker, Workshop Dynamical Systems, Reaction Kinetics and Applications, July 2–4 2025, Zagreb, Croatia
4. *Sliding cycles in regularized PWL visible-invisible twofolds*, Workshop Divergent series, slow-fast systems and piecewise linear systems, Sep 2 2024, Hasselt, Belgium
5. *Fractal Hilbert's 16th problem and slow-fast Liénard equations*, Invited speaker, Dynamics Days Europe, Sep 3–8 2023, Naples, Italy
6. *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
7. *A new approach for detection of nonzero Lyapunov coefficients*, Seminar, University of Groningen, The Netherlands, 18 April 2023
8. *A new approach for detection of nonzero Lyapunov coefficients*, International Online GSDUAB Seminar, Barcelona, 6 March 2023
9. *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
10. *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
11. *Predator-prey slow-fast cycles and Hilbert's 16th problem*, Talk, EQUADIFF, 11–15 July 2022, Brno, Czech Republic
12. *Fractal analysis of slow-fast systems*, Talk, Bifurcations of dynamical systems, Workshop, 9th–12th February, 2022, Zagreb, Croatia.
13. *Fractal dimensions and 2-dimensional slow-fast systems*, Talk, DynamicsDays2021, Nice, France, August 2021.
14. *Period function near planar turning points*, Talk, NoLineal 20-21 Online, Madrid, Spain, June 30-July 2, 2021.
15. *Period function near planar turning points*, Talk, SIAM Conference on Applications of Dynamical Systems (DS21), held virtually May 23-27, 2021.
16. *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>

17. *Cyclicity of canard cycles with hyperbolic saddles located away from the slow curve*, Seminar, University of Edinburgh, UK, December 3-5, 2019
18. *Slow-fast Darboux systems*, Dynamics, Equations and Applications (DEA 2019), Invited speaker, Kraków, Poland, 16th to 20th September 2019
19. *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
20. *Slow-fast systems on a Möbius band*, Invited speaker, SIAM Conference on Applications of Dynamical Systems (DS19), Snowbird, Utah, May 19 - 23, 2019.
21. *The slow divergence integral on a Möbius 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.
22. *The slow divergence integral on a Möbius band and Quartic Lienard equations with linear damping*, Invited speaker, ZAGREB DYNAMICAL SYSTEMS WORKSHOP 2018, October 22–26, Zagreb, Croatia
23. *Slow-fast bifurcations and Hilbert’s 16th problem*, Invited speaker, SPT 2018, Cagliari, Italy, June 2018
24. *Box dimension and cyclicity of canard cycles*, University of Zagreb, Croatia, April 2018
25. *Normal forms of Liénard type, slow-fast bifurcations and fractal geometry of canard cycles*, Hasselt University, Belgium, November, 2017
26. *Normal forms of Liénard type, slow-fast bifurcations and fractal geometry of canard cycles*, University of Toulouse, France, November, 2017
27. *Regular and slow-fast codimension 4 saddle-node bifurcations*, EquaDiff 2017
28. *Regular and slow-fast codimension 4 saddle-node bifurcations*, University of Zagreb, Croatia, April 2017
29. *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
30. *Codimension 4 saddle-node bifurcations*, Talk given at York University, November 15 – 28, 2015, Toronto, Canada
31. *Geometric singular perturbation theory and planar slow-fast systems*, Talk given at Institute of Mathematics, Hanoi, Vietnam, September 7–19, 2015
32. *Limit cycles in Liénard equations and blow-up techniques*, Talks given at Plymouth University, April 12 – May 1, 2015, Plymouth, England
33. *Slow-fast codimension 3 bifurcations*, Talk given at Fourth PhD-Day: Royal Academy, September 9, 2013, Brussel, Belgium
34. *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
35. *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
36. *Poster Limit cycles in slow-fast codimension 3 saddle and elliptic bifurcations*, September 12 – 16, 2011, Castro Urdiales, Spain