JUSTYNA SIGNERSKA-RYNKOWSKA

justyna.signerska@pg.edu.pl

Division of Differential Equations and Applications of Mathematics ul. Narutowicza 11/12
Institute of Applied Mathematics 80-233 Gdańsk
Gdańsk University of Technology POLAND

Education

2009 - 2013 **Ph. D. studies** at the Institute of Mathematics of the Polish Academy of Sciences (acclaimed as **Leading National Research Centre** for 2012-2017 by Ministry of Science and Higher Education in Poland) in the field of *Mathematics* under supervision of prof. W. Marzantowicz (the Ph.D. advisor) and prof. F. Przytycki (co-advisor), **Ph.D. in *Mathematics*** in June 2013; title of Ph. D. Thesis "Dynamical properties of maps arising in some models of neuron activity and electrical circuits"

2004 - 2009 Gdańsk University of Technology (Poland), Faculty of Applied Physics and Mathematics, **M. Sc. Eng. in *Applied Mathematics*** in July 2009 (with final grade *excellent*); title of Master Thesis: "Mathematical Analysis of Some Simple Spiking Neuron Models"

2000 - 2004 International Baccalaureate School No 0704 in Gdynia (Poland) (International Baccalaureate Diploma)

Employment

Since 2016 **assistant professor** at Gdańsk University of Technology, Faculty of Applied Physics and Mathematics, Division of Differential Equations and Mathematics Applications

2021-2024 **visiting assistant professor** at the Dioscuri Centre in Topological Data Analysis (Institute of Mathematics, Polish Academy of Sciences)

2014 - 2016 **post-doctoral position** at INRIA Paris-Centre (EPI MYCENAE) and Mathematical Neuroscience Lab, CIRB - Collège de France

2013 - 2014 **post-doctoral position** at the Institute of Mathematics of the Polish Academy of Sciences (Department of Dynamical Systems)

2012 - 2014 **Organization and Training Coordinator** in the Project "Center for Applications of Mathematics" at Gdańsk University of Technology

2009 - 2012 **lecturer** at the Faculty of Applied Physics and Mathematics, Gdańsk University of Technology (Department of Non-linear Analysis)

Research Interests

- dynamical systems, chaos theory, topological methods in dynamical systems

- application of dynamical systems theory to modelling of biological and physical phenomena, especially applications in neuroscience

Publications (selected)

- P. Bartłomiejczyk, P. Nowak-Przygodzki, J. Signerska-Rynkowska, *Multilevel regularity of orbits of expanding Lorenz maps with application to the Courbage-Nekorkin-Vdovin model*. **Discrete Contin. Dyn. Syst. Ser. B** 30, 4185-4205 (2025)
- P. Dłotko, M. Lipiński, J. Signerska-Rynkowska, *Testing topological conjugacy of time series from finite sample,* **SIAM J. Appl. Dyn. Syst.** 23, 939--2982 (2024)
- P. Bartłomiejczyk, F.L. Trujillo, J. Signerska-Rynkowska, *Analysis of dynamics of a map-based neuron model via Lorenz maps,* **Chaos** 34, 043110 (2024)
- P. Bartłomiejczyk, F.L. Trujillo, J. Signerska-Rynkowska, *Spike patterns and chaos in a map-based neuron model,* International Journal of Applied Mathematics and Computer Science (**AMCS**) 33, 395-408 (2023)
- P. Pilarczyk, J. Signerska-Rynkowska, G. Graff, *Topological-numerical analysis of a two-dimensional discrete neuron model,* **Chaos** 33, 043110 (2023)
- F.L. Trujillo, J. Signerska-Rynkowska, P. Bartłomiejczyk, *Periodic and chaotic dynamics in a map-based neuron model,* **Math Meth Appl Sci.** (2023); 1- 26.
- J. Signerska-Rynkowska, *On Computing Curlicues Generated by Circle Homeomorphism*, in *Sharing Research Data Across Disciplines*, Politechnika Gdańska, 2022
- J. Signerska-Rynkowska, *Curlicues generated by circle homeomorphisms.* **Geom. Dedicata** 216, 15 (2022).
- J.E. Rubin, J. Signerska-Rynkowska, J.D. Touboul, *Type III Responses to Transient Inputs in Hybrid Nonlinear Neuron Models*, **SIAM J. Appl. Dyn. Syst.** 20 (2021), p.953—980
- G. Graff, J. Signerska-Rynkowska, *Dynamics of field line mappings in magnetic flux tubes*, **Math. Phys. Anal. Geom.** 21, 26 (2018)
- P. Kasprzak, A. Nawrocki, J. Signerska-Rynkowska, *Integrate-and-fire models with an almost periodic input function*, **J. Differential Equations** 264 (2018), p. 2495–2537
- J.E. Rubin, J. Signerska-Rynkowska, J.D. Touboul, A. Vidal, *Wild oscillations in a nonlinear neuron model with resets: (II) Mixed-mode oscillations*, **Discrete Contin. Dyn. Syst. Ser. B**, 22 (2017), p. 4003-4039.
- J.E. Rubin**,** J. Signerska-Rynkowska, J.D. Touboul, A. Vidal, *Wild oscillations in a nonlinear neuron model with resets: (I) Bursting, spike adding and chaos*, **Discrete Contin. Dyn. Syst. Ser. B**, 22 (2017), p. 3967-4002.
- J. Signerska-Rynkowska, *Analysis of interspike-intervals for the general class of integrate-and-fire models with periodic drive*, **Mathematical Modeling and Analysis**, 20 (2015), 529–551
- W. Marzantowicz, J. Signerska, *On the regularity of the displacement sequence of an orientation preserving circle*, Research and Communications in Mathematics and Mathematical Sciences, 5 (2015), p.11-32
- W. Marzantowicz, J. Signerska, *On the interspike-intervals of periodically-driven integrate-and-fire models*, **Journal of Mathematical Analysis and Application**s, 423 (2015), p.456–479
- W. Marzantowicz, J. Signerska, *Distribution of the displacement sequence of an orientation preserving circle homeomorphism*, **Dynamical Systems: An International Journal**, 29 (2014), no. 2, p.153-166

- G. Graff, A. Kaczkowska, P. Nowak-Przygocki, J. Signerska, *Lefschetz periodic point free self-maps of compact manifolds*, **Topology and its Applications**, 159 (2012), p.2728-2735
- W. Marzantowicz, J. Signerska, *Firing map of an almost periodic input function*, **Discrete and Continuous Dynamical Systems**, Supplement 2011-2 (2011), p.1032-1041

Grants and Awards

- **Award of the association Polish Women in Mathematics** (PTKM) for outstanding scientific achievements in years 2017-2022 (March 2023)

- **Principal Investigator** in the "**SONATA**" grant *Challenges of low-dimensional dynamics in hybrid neuron models*, awarded by National Science Centre in Poland in May 2020 (duration: 48 months)

- post-doc in the **Dioscuri** Centre in Topological Data Analysis (Dioscuri Centres of Scientific Excellence - a programme initiated by the Max Planck Society (MPG), jointly managed with the National Science Centre in Poland (NCN), and mutually funded by the Polish Ministry of Science and Higher Education (MNiSW) and the German Federal Ministry of Education and Research (BMBF))

- team member in "*ScienceApp* -intensive international educational programs in exact sciences" (project within the frame of the **SPINNAKER** program, granted by the Polish National Agency for Academic Exchange/ Funds (**NAWA**))

- honorable mention in Edyta Szymańska competition for scientific papers published in 2017-2018, organized by Adam Mickiewicz University in Poznań

- co-investigator in the "**OPUS**" grant *Topological Invariants and Complexity Measures in Action*, awarded by National Science Centre in Poland in May 2015

- **Principal Investigator** in the pre-doctoral grant "**PRELUDIUM**" awarded by National Science Centre in Poland in December 2011 for executing the project *Properties of dynamical systems used in mathematical modelling of neurons activity and electrical circuits* (duration: 24 months)

- Rector's Awards (Gdańsk University of Technology): for outstanding scientific achievements (individual, 2017), research-and-development activity (individual, 2020), organizational activity (team award, 2018 and 2020, individual 2022), for outstanding didactic achievements (individual, 2021; team award 2021),

- Scholarship of the Ministry of Science and Higher Education for academic achievements in academic years 2006/2007, 2007/2008, 2008/2009

- Scholarship of the Marshal of Pomeranian Voivodeship for academic achievements in academic years 2007/2008, 2008/2009 and of Mayor of Gdynia/Gdańsk in 2006/2007, 2007/2008

Short-term scientific visits (selected)

- 19 - 26 January 2025, **University of Pittsburg** (USA, PA), Department of Mathematics

- 26 November - 3 December 2023, **Brandeis University** (USA, MA), Department of Mathematics

- 28-31 August 2016 and 15-17 May 2023, **Linköping University** (Sweden), Department of Mathematics

- 1-8 June 2016 and 2-11 December 2013, Center for Interdisciplinary Research in Biology, **Collège de France**, Paris: visiting the group of Jonathan Touboul and working on the project

"Wild dynamics in nonlinear integrate-and-fire neurons: mixed-mode bursting, spike adding and chaos"

- 15-29 January 2014, Instituto de Ciências Matemáticas e de Computação, **Universidade de São Paulo**, São Carlos –SP, Brasil: visiting the group of Ali Tahzibi and working on the project about geometrical properties of curlicues generated by circle maps and other dynamical systems

- 7-11 January 2013, **Ecole Normale Supérieure** (Paris): visiting the group of Romain Brette in theoretical and computational neuroscience

Attended Conferences and Workshops (after 2014, selected)

- 17 - 20 June 2025, Barcelona (Spain), **International Conference on Mathematical Neuroscience (ICMNS 2025)**, **talk** *Understanding neuronal responses to transient inputs: a dynamical systems approach*
- 5 - 7 May 2025, Gdańsk (Poland), **Workshop on Industrial and Applied Mathematics: Gdańsk Tech Joins ECMI**, **talk** *Topological data analysis enhances investigation of dynamical systems*
- 7 - 11 April 2025, Poznań (Poland), 95th Annual Meeting of the International Association of Applied Mathematics and Mechanics (**GAMM 2025**), **talk** *Quantifying time series similarity using topological conjugacy and related concepts*
- 14 - 16 January 2025, Gdańsk (Poland), International Conference **Applied Topology and Dynamical Systems; Organizing and Scientific Committee**
- 26 - 27 November 2024, Gdańsk (Poland), **Workshop on Mathematical Analysis of Biomedical Time Series**, **talk** *Testing topological conjugacy of time series*; **Organizing and Scientific Committee**
- 11 - 15 November 2024, Montréal (Canada), **Workshop - Data driven dynamics**, **talk** *Testing topological conjugacy of time series*
- 16-21 September 2024, Zakopane (Poland), **52nd Conference on Applications of Mathematics,** **talk** *Understanding neuronal responses to transient inputs: a dynamical systems approach*
- 26-28 June 2024, Łódź (Poland), **Dynamical Systems and Applications VI, DSA 2024**; **invited session talk** *A new insight into the dynamics of the Chialvo model*
- 17-21 June 2024, Toruń (Poland), **VIII Symposium on Nonlinear Analysis**; **invited session talk** *Testing topological conjugacy of time series*
- 29 - 31 January 2024, Gdańsk (Poland), International Conference **Topological Invariants in Fixed Point Theory and Dynamical Systems**; **Organizing and Scientific Committee**
- 7 November 2023, Poznań (Poland), Scientific Conference „Zostanę Noblistką. Kobiety w naukach ścisłych", **invited talk** *Jak matematyka może pomóc opisać świat i sama na tym skorzystać ? Metody nieliniowe i topologiczne w modelowaniu neuronów i analizie szeregów czasowych*
- 10 - 16 September 2023, Zakopane (Poland), **51st Conference on Applications of Mathematics**, **talk** *Testing Topological Conjugacy of Time Series*
- 26-30 June 2023, Wrocław (Poland), **22nd ECMI Conference on Industrial and Applied Mathematics**, mini-symposium talk *Dynamics reconstruction from finite sample na Minisympozium on topological data analysis*

- 19-23 June 2023, Gdańsk (Poland), **International Summer School „Topology and Dynamical Systems in Action"**, giving **mini-course** *Nonlinear dynamics in hybrid neuron models*
- 27 February 2023, Warsaw (Poland), **Symposium of Nencki Institute of Experimental Biology - Laboratory of Neuroinformatics and IMPAN - Dioscuri Centre in TDA; talks** *Dynamics reconstruction from finite sample* (with Michał Lipiński) and *A couple of interesting phenomena in hybrid neuron models*
- 23-25 November 2022, Gdańsk (Poland), **Mathematics for Society: Health, Industry and Sustainable Development**; **Organizing and Scientific Committee; talk** *Testing topological conjugacy of time series*
- 15 - 17 September 2022, Gdańsk (Poland), **On the Trail of Women in Mathematics: Contemporary Women in Mathematics**; **invited talk** *From experiments to non-linear dynamics: a couple of results in modeling of neural activity*
- 6 - 10 September 2022, Wisła (Poland), **National Conference Application of Mathematics to Biology and Medicine**; **talk** *Type III responses to transient inputs in hybrid nonlinear neuron models*
- 18-20 July 2022, Florence (Italy), **COMPENG 2022** (IEEE Workshop on Complexity in Engineering); **talk** *On Takens theorem and embedding methods*
- 3-8 July 2022, Będlewo (Poland), **Applied Topology in Będlewo 2022; Organizing Committee**
- 2-3 July 2022, Poznań (Poland), **Introduction to Computational Mathematics, Organizing Committee**
- 1-3 December 2021, Gdańsk (Poland), **Workshop on Topological Analysis of Medical Data**, **Organizing Committee; talk** *Topological-numerical analysis of a 2-dimensional dynamical neuron model*
- 20 – 26 June 2021, Portorož (Slovenia) – virtual conference, **8th European Congress of Mathematics; minisymposium invited talk** *Dynamical mechanisms of Type III responses in a nonlinear hybrid neuron model*
- 23 - 27 May 2021, Portland (USA) – virtual conference, **SIAM Conference on Applications of Dynamical Systems; minisymposium invited talk** *Type III Responses to Transient Inputs in a Nonlinear Hybrid Neuron Model*
- 27 February – 1 March 2020, Gdańsk (Poland), **Wandering Seminar, Organizing Committee**
- 3 – 7 September 2019, Cracov (Poland), Jubilee Congress for the 100th anniversary of the Polish Mathematical Society (Jubileuszowy Zjazd Matematyków Polskich w stulecie PTM), **talk** *Teoria rotacji w hybrydowych modelach neuronów* (in Polish)
- 31 August – 2 Sept 2019, Cracov, **On the Trail of Women in Mathematics - in Honor of Sofia Kowalewska**; **invited session talk** *Integrate-and-fire models with an almost periodic input function*
- 10–14 June 2019 Cracov, **Conference on Dynamical Systems Celebrating Michał Misiurewicz's 70th Birthday**, **talk** *Period incrementing and chaos in a hybrid neuron model*
- 15-21 April 2018, Będlewo (Poland), **Surfaces in Będlewo, Organizing Committee**
- 18-22 September 2017, Lublin (Poland), **8th Forum of Polish Mathematicians, co-organizer of session** *Topological Methods in Dynamical Systems*, **talk** *Curlicues generated by circle homeomorphisms*
- 13-19 August 2017, Będlewo (Poland), **Just a Little Calculation in Dynamics**; **talk** *Rotation theory and mixed-mode oscillations in a hybrid neuron model*
- 22-24 June 2017, Rzeszów (Poland), **Women in Mathematics: conference in honor of Helena Rasiowa; invited session talk** *Period-incrementing and chaos in hybrid neuron model*

- 30 May – 2 June 2017, Boulder (Colorado, USA), **3rd International Conference on Mathematical NeuroScience**; **talk** *Complex oscillations in a hybrid neuron model: bursting, spike-adding and chaos*
- 3-7 October 2016, CIRM - Marseille, **Surfaces in Luminy**, **poster** *Rotation theory in analysing hybrid neuron models*
- 18-22 July 2016, Berlin, **7th European Congress of Mathematics**, **talk** *Rotation theory in analysis of complex oscillations in a hybrid neuron model*
- 30 May – 1 June 2016, Antibes-Juan Les Pins (France), **2nd International Conference on Mathematical NeuroScience**; **poster** *Circle maps and rotation theory in analysing hybrid neuron models*
- 25-30 May 2015, Będlewo (Poland), **Between Theory and Applications: Mathematics in Action;** chairman and organizer of session Dynamical systems in modeling of neural activity; **lecture** Discontinuous interval mappings in analysis of integrate-and-fire models
- 16-21 May 2015, Snowbird (Utah, USA), **SIAM Conference on Applications of Dynamical Systems; poster** A geometric mechanism for mixed-mode bursting oscillations in a hybrid neuron model

Seminars given (invited, selected)

1) **University of Pittsburg** (USA, PA), Mathematical Biology Seminar, "Dynamical Similarity of Time-Series" (January 2025)

2) **Institute of Mathematics of Polish Academy of Sciences**, IMPAN Colloquium, "Low-dimensional dynamics enhancing modeling of neuronal activity" (January 2025)

3) **Institute of Mathematics of Polish Academy of Sciences**, Seminar on Approximation Theory and Stochastic Analysis "Rotation Theory, S-unimodal maps and geometric singular theory in the study of dynamics of hybrid neuron models" (May - June 2024)

4) **Institute of Mathematics of Polish Academy of Sciences**, Seminar on Dynamical Systems "Testing topological conjugacy of time series" (October 2023)

5) **Linköping University** (Sweden) - Statistics Seminar, "Some results in low-dimensional dynamics and their applications to modeling of neural activity" (May 2023)

6) **Institute of Mathematics of Polish Academy of Sciences**, Seminar on Approximation Theory and Stochastic Analysis "Testing topological conjugacy from finite sample" (January and February 2023)

7) **University of Łódź**, Seminar of the Department of Geometry, "On entropy in time-series analysis (and not only)" (March 2022)

8) **Brandeis Mathematical Biology Seminar** "Type III dynamics and beyond in shaping responses to transient inputs in hybrid neuron models" (2021)

9) **Polish Women in Mathematics Seminar** (PolWoMaths Seminar) "Selected problems of low-dimensional dynamics in neurons modeling" (2021)

10) **Linköping University** (Sweden), Department of Mathematics, "Complex oscillations in a nonlinear neuron model with resets" (2016)

11) **Instituto de Ciências Matemáticas e de Computação, Universidade de São Paulo**, **São Carlos** (Brasil), "Displacement sequence of an orientation preserving circle homeomorphism" and "Firing map and interspike-intervals for one-dimensional integrate-and-fire models" (2014)

12) **Institute of Mathematics of PAS, Warsaw**, *Dynamical systems* seminar, "Firing map for periodically and almost-periodically driven integrate-and-fire models: a dynamical systems approach" and "Curlicues generated by circle maps" (2012 and 2014)

13) **Jagiellonian University in Cracov**, *Dynamical systems* seminar, "Analysis of a neuron dynamics model with a periodic and almost periodic input function" (2012)

14) **Adam Mickiewicz University in Poznan**, *Seminar in Nonlinear Analysis*, "Analysis of a neuron dynamics model with an almost periodic input function" (2012)

Editorial and Reviewing activities

Since 2023 Editorial Board of *MATHEMATICA APPLICANDA* (ISSN 0137-2890)

Since 2024 Jury of Kazimierz Kuratowski Award (awarded by the Institute of Mathematics of the Polish Academy of Sciences and the Polish Mathematical Society)

Reviewer for PLOS Computational Biology, Journal of Mathematical Neuroscience, SIAM Journal on Applied Dynamical Systems**,** Chaos Solitons & Fractals, Journal of Difference Equations and Applications, Mathematical Reviews

Memberships

Since 2014 Polish Mathematical Society (PTM), since January 2017 treasurer of the Gdansk Branch

Since 2020 Polish Women in Mathematics Society (PTKM)

Others

- Languages: English (Certificate in Advanced English-CAE; full professional proficiency); German (Goethe-Zertifikat C1); French (intermediate)