

Sören von der Gracht, born Schwenker

Contact Data

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Current Position

Postdoctoral Researcher with Prof. M. Dellnitz
Institute of Mathematics, Paderborn University 09/22–present
Project: Algorithms for Swarm Robotics: Distributed Computing meets Dynamical Systems

Education

Dr. rer. nat.
Universität Hamburg, (magna cum laude) 10/15–12/19
Mathematics
MSc
Universität Hamburg, (excellent with distinction) 10/13–09/15
Mathematics
BSc
Universität Hamburg, (excellent) 10/10–09/13
Mathematics

Employment

Postdoctoral Researcher with Prof. R. Lauterbach and Prof. I. Gasser
Department of Mathematics, Universität Hamburg 10/19–09/22
Postdoctoral Researcher with Prof. T. Schramm
Department of Geodesy and Geoinformatics, HafenCity Universität Hamburg 01/20–12/20
Project: Linear Algebra Driven by Data Science
Research Associate with Prof. R. Lauterbach
Department of Mathematics, Universität Hamburg 10/15–09/19

Other.....

Parental Leave: 09/21–11/21 and 04/21–07/21

Research Interest

Network Dynamical Systems: Genericity, Bifurcation Theory, Application of Representation Theory, Connections to Equivariant Dynamics, Heteroclinic Dynamics, Higher-Order Interactions, Applications to Real-World Systems

Equivariant Dynamics: Genericity, Bifurcation Theory

Representation Theory: Decomposition of Representations, Monoid Representations, Quiver Representations, Connections to Networks

Publications*

Original Research Articles.....

R. Gerlach, **von der Gracht, S.**, and M. Dellnitz. "On the Dynamical Hierarchy in Gathering Protocols with Circulant Topologies". In: *Structural Information and Communication Complexity*. Ed. by U. Schmid and R. Kuznets. Vol. 15671. Lecture Notes in Computer Science 15671. Cham: Springer Nature Switzerland, 2025, pp. 315–332.

R. Gerlach, **von der Gracht, S.**, C. Hahn, J. Harbig, and P. Kling. "Symmetry Preservation in Swarms of Oblivious Robots with Limited Visibility". In: *28th International Conference on Principles of Distributed Systems (OPODIS 2024)*. Ed. by S. Bonomi, L. Galletta, E. Rivière, and V. Schiavoni. Vol. 324. Leibniz International Proceedings in Informatics (LIPIcs). Dagstuhl, Germany: Schloss Dagstuhl – Leibniz-Zentrum für Informatik, 2025, 13:1–13:28.

C. Bick and **von der Gracht, S.** "Heteroclinic dynamics in network dynamical systems with higher-order interactions". *Journal of Complex Networks* 12.2 (2024).

von der Gracht, S., E. Nijholt, and B. Rink. "Higher-order interactions lead to 'reluctant' synchrony breaking". *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences* 480.2301 (2024), p. 20230945.

von der Gracht, S., E. Nijholt, and B. Rink. "Hypernetworks: Cluster Synchronization Is a Higher-Order Effect". *SIAM Journal on Applied Mathematics* 83.6 (2023), pp. 2329–2353.

von der Gracht, S., E. Nijholt, and B. Rink. "Amplified steady state bifurcations in feedforward networks". *Nonlinearity* 35.4 (2022), pp. 2073–2120.

E. Nijholt, B. Rink, and **Schwenker, S.** "A new algorithm for computing idempotents of \mathcal{R} -trivial monoids". *Journal of Algebra and its Applications* 20.12 (2021).

E. Nijholt, B. W. Rink, and **Schwenker, S.** "Quiver Representations and Dimension Reduction in Dynamical Systems". *SIAM Journal on Applied Dynamical Systems* 19.4 (2020), pp. 2428–2468.

Schwenker, S. "Generic Steady State Bifurcations in Monoid Equivariant Dynamics with Applications in Homogeneous Coupled Cell Systems". *SIAM Journal on Mathematical Analysis* 50 (3 2018), pp. 2466–2485.

R. Lauterbach and **Schwenker, S.** "Equivariant bifurcations in four-dimensional fixed point spaces". *Dynamical Systems* 32.1 (2017), pp. 117–147.

*Family name changed from Schwenker to von der Gracht in 2020

Submitted.....

R. Gerlach and **von der Gracht, S.** "Analyzing Symmetries of Swarms of Mobile Robots Using Equivariant Dynamical Systems" (2025). arXiv: 2503.07576.

von der Gracht, S., E. Nijholt, and B. Rink. "A parametrisation method for high-order phase reduction in coupled oscillator networks" (2023). arXiv: 2306.03320.

Other publications.....

T. Schramm, I. Gasser, **S. Schwenker**, R. Seiler, A. Lohse, K. Zobel "Linear Algebra driven by Data Science". *Open Educational Resource at the Hamburg Open Online University* (2020), URL: <https://www.hoou.de/projects/linear-algebra-driven-by-data-science/>

E. Nijholt, B. Rink, **S. Schwenker** "Generalised Symmetry in Network Dynamics". *Popular Article in DS Web April* (2020), URL: <https://dsweb.siam.org/The-Magazine/Article/generalised-symmetry-in-network-dynamics>

Theses

Dissertation: *Genericity in Network Dynamics*, Supervisor: Prof. R. Lauterbach

Master's Thesis: *Equivariant Bifurcations in \mathbb{R}^8 and the Ize Conjecture*, Supervisor: Prof. R. Lauterbach

Bachelor's Thesis: *Instabilität der "logrolling" Lösung in Flüssigkristallen unter Scherströmung (Instability of the "logrolling" solution in liquid crystals under shear flow)*, Supervisor: Prof. R. Lauterbach

Presentations

Invited Conference Presentations.....

Intriguing dynamics on hypergraphs: a focus on directed higher order interactions: 0 mod 10 workshop (VU Amsterdam, NL, 10/07/2025)

Reluctant Synchrony Breaking in Directed Hypernetworks: XLV Dynamics Days Europe (Thessaloniki, GR, 24/06/2025)

Heteroclinic dynamics in network dynamical systems with higher-order interactions: SIAM Conference on Applications of Dynamical Systems (Denver, CO, USA, 12/05/25)

Reluctant synchrony breaking in hypernetworks: XLIV Dynamics Days Europe (Bremen, D, 29/07/2024)

Strange symmetries and strange bifurcations in network dynamical systems: Dynamical Systems in Porto - Dynamics of singularities and networks (Porto, PT, 15/11/2023)

How higher order interactions shape the dynamics of hypernetworks: SIAM Conference on Applications of Dynamical Systems (Portland, OR, USA, 17/05/23)

Generalising Symmetry via Quiver Representations: Equivariant Dynamics and Applications: SIAM Conference on Nonlinear Waves and Coherent Structures (Bremen, D, 02/09/22)

Generalising Symmetry in Equivariant Dynamics using Quiver Representations: SIAM Conference on Applications of Dynamical Systems (virtual conference, 27/05/21)

Generalized Feedforward Networks: Algebraic Structure and Steady State Bifurcations: SIAM Conference on Applications of Dynamical Systems (Snowbird, UT, USA, 19/05/19)

Generic steady state bifurcations in monoid equivariant dynamical systems: Workshop on Emerging Topics in Network Dynamical Systems (Lorentz Center, Leiden, NL, 07/06/17)

Invited Seminar Talks.....

Higher order interactions cause exotic dynamics, especially directed ones: Oberseminar Dynamics (Technical University of Munich, 21/07/25)

Model independent phenomena in network dynamical systems: Oberseminar Numerics and Control (Paderborn University, 22/05/25)

Symmetries in configurations of mobile robots: Oberseminar Angewandte Mathematik (Paderborn University, 23/01/25)

Exotic bifurcations in network dynamical systems: Dynamical Systems and Ergodic Theory Seminar (ICMC—Universidade de São Paulo, 28/08/2024)

Exploring exotic symmetries to explain exotic behavior of network dynamical systems: Oberseminar Nonlinear Dynamics (Freie Universität Berlin, 16/07/2024)

Higher order interactions shape dynamics differently than diadic interactions: Oberseminar Angewandte Mathematik (Paderborn University, 09/11/23)

Amplification in feedforward networks: Applied Dynamics Seminar (Universität Hamburg, 22/11/22)

An introduction to dynamical networks and their symmetries: Oberseminar Angewandte Mathematik (Paderborn University, 10/11/22)

Amplification in general feedforward networks: Dynamics Seminar (Vrije Universiteit Amsterdam, 16/06/22)

Quiver representations as generalised symmetries in network dynamics: Lowlands Dynamics Seminar (joint virtual seminar of the Vrije Universiteit Amsterdam and the Universität Hamburg, 24/03/21)

Homogeneous coupled cell systems - Hidden symmetries and representation theory: Dynamics Seminar (Vrije Universiteit Amsterdam, 23/01/19)

Homogeneous coupled cell systems: unexpected symmetries and how to exploit them in bifurcation analysis: Dynamical Systems Seminar (Universidade do Porto, 22/06/18)

Networks: Nonsymmetric, yet symmetric - An Introduction to Hidden Symmetries in Network Dynamical Systems: Lothar-Collatz-Seminar (Universität Hamburg, 20/12/17)

Generische Bifurkationen von Ruhelagen in Monoid-äquivalenten dynamischen Systemen: AG Dynamische Systeme (Universität Hamburg, 12/05/17)

Posters.....

Gathering a robot swarm using circulant communication strategies: 10th International Congress on Industrial and Applied Mathematics (Tokyo, JP, 25/08/23)

Generic steady state bifurcations in homogeneous coupled cell networks and related equivariant dynamics: SIAM Workshop on Network Dynamics (Pittsburgh, PA, USA, 14/07/17)

Generic Steady State Bifurcations in Homogeneous Coupled Cell Networks: SIAM Annual Meeting (Pittsburgh, PA, USA, 11/07/17)

Grants and Funding

DAAD: Travel Award to visit T. Pereira and E. Nijholt at ICMC—Universidade de São Paulo 2024 (approx. €2,500)

DFG: Conference Support Grant for the Workshop on Nonlinear Dynamics 2024 together with Dr. A. Lohse (€20,000)

ICIAM: Financial Support Grant for the 10th International Congress on Industrial and Applied Mathematics 2023 (approx. €300)

DAAD: Travel Award to the 10th International Congress on Industrial and Applied Mathematics 2023 (approx. €2,000)

DAAD: Travel Award to the SIAM Conference on Applications of Dynamical Systems 2019 (approx. €2,000)

SIAM Student Chapter Universität Hamburg: Travel Award to the SIAM Annual Meeting and the SIAM Workshop on Network Dynamics 2017 (approx. €2,100)

SIAM: Travel Award to the SIAM Annual Meeting 2017 (approx. €600)

MIN-Graduiertenschule der Universität Hamburg: Travel Award to the Workshop on Emerging Topics in Network Dynamical Systems 2017 (€100)

Carl Christiansen-Gedächtnis-Stiftung: Travel Award to the SIAM Conference on Applications of Dynamical Systems 2017 (€900)

MIN-Graduiertenschule der Universität Hamburg: Travel Award to the SIAM Conference on Applications of Dynamical Systems 2017 (€1,250)

Honors

03/25: IOP Publishing Outstanding Reviewer Awards 2024

Organized Events

Minisymposium *Dynamics of Higher-order Interaction Networks: Theory and Applications*: SIAM Conference on Applications of Dynamical Systems (14/05/25)

Minisymposium *Realization of connection structures in phase space*: XLIV Dynamics Days Europe Bremen (29/07/2024)

Workshop on Nonlinear Dynamics 2024: Universität Hamburg (24/07/24–26/07/24)

Minisymposium *Hypernetworks and their dynamics in theory and applications*: 10th International Congress on Industrial and Applied Mathematics (25/08/23)

Minisymposium *Novel approaches to networks with varying topologies*: SIAM Conference on Applications of Dynamical Systems (17/05/23)

Minisymposium *Dynamics of and on Networks*: SIAM Conference on Applications of Dynamical Systems (24/05/21)

Minisymposium *Novel Directions in Network Dynamical Systems*: SIAM Conference on Applications of Dynamical Systems (19/05/19)

Conferences

0 mod 10 workshop: Amsterdam, NL, 09/07/25–11/07/25

XLV Dynamics Days Europe: Thessaloniki, GR, 23/06/25–27/06/25

SIAM Conference on Applications of Dynamical Systems: Denver, CO, USA, 11/05/25–15/05/25

DinAmicl in Rio, Dynamics, Applications, Interactions: Rio de Janeiro, BR, 02/09/24–06/09/24

XLIV Dynamics Days Europe: Bremen, D, 29/07/24–02/08/24

Workshop on Nonlinear Dynamics: Hamburg, D, 24/07/24–26/07/24

International Workshop: Dynamics in Coupled Network Systems: Berlin, D, 20/11/23–22/11/23

Dynamical Systems in Porto: Porto, PT, 01/11/2023–17/11/2023

10th International Congress on Industrial and Applied Mathematics: Tokyo, JP, 20/08/23–25/08/23

SIAM Conference on Applications of Dynamical Systems: Portland, OR, USA, 14/05/23–18/05/23

SIAM Conference on Nonlinear Waves and Coherent Structures: Bremen, D, 30/08/22–02/09/22

SIAM Conference on Applications of Dynamical Systems: virtual conference, 23/05/21–27/05/21

Hamburg Shrinking Targets Workshop: Hamburg, D, 13/11/19–15/11/19

Hanseatic Dynamical Systems Days: Bremen, D, 21/06/19

SIAM Conference on Applications of Dynamical Systems: Snowbird, UT, USA, 19/05/19–23/05/19

Hanseatic Dynamical Systems Days: Lübeck, D, 23/11/18

Hanseatic Dynamical Systems Days: Hamburg, D, 29/06/18

SIAM Workshop on Network Dynamics: Pittsburgh, PA, USA, 13/07/17–14/07/17

SIAM Annual Meeting: Pittsburgh, PA, USA, 10/07/17–14/07/17

Workshop on Emerging Topics in Network Dynamical Systems: Leiden, NL, 06/06/17–09/06/17

SIAM Conference on Applications of Dynamical Systems: Snowbird, UT, USA, 21/05/17–25/05/17

Annual Meeting of the German Mathematical Society 2015: Hamburg, D, 21/09/15–25/09/15

Academic Visits

ICMC—Universidade de São Paulo

Invitation by T. Pereira and E. Nijholt

São Carlos, Brazil

19/08/24–30/08/24

Vrije Universiteit Amsterdam

Invitation by C. Bick

Amsterdam, Netherlands

14/06/22–17/06/22

Vrije Universiteit Amsterdam

Invitation by B. Rink

Amsterdam, Netherlands

14/01/19–01/02/19

Universidade do Porto

PPP Projekt Heterokline Dynamik: Stabilität und Bifurkationen

Porto, Portugal

19/06/18–23/06/18

Vrije Universiteit Amsterdam

Invitation by B. Rink

Amsterdam, Netherlands

15/04/18–20/04/18

Vrije Universiteit Amsterdam

Invitation by B. Rink and E. Nijholt

Amsterdam, Netherlands

21/08/17–25/08/17

Professional Societies

Society for Industrial and Applied Mathematics

Referee

Journal of Dynamics and Differential Equations

Journal of Physics A: Mathematical and Theoretical

Nonlinearity

SIAM Journal on Applied Dynamical Systems

Mathematical Reviews – MathSciNet

Teaching

Independent Teaching.....

Modellieren und Anwendungen: Dynamische Prozesse

(Modelling and Applications: Dynamical Processes)

Winter 2024

Bachelor course for students in teacher training at Paderborn University

Dynamische Systeme mit Netzwerkstruktur

(Network Dynamical Systems)

Winter 2024

Master course for mathematics students at Paderborn University

An introduction to generic bifurcation theory

Minicourse for PhD and Master's students at the ICMC—Universidade de São Paulo

August 2024

Teaching Assistant.....

Analysis III: Winter 2021, Winter 2019, Winter 2017, Winter 2013

Analysis II: Summer 2019, Summer 2015, Summer 2013

Analysis I: Winter 2015, Winter 2014, Winter 2012

Differential Equations I: Winter 2020, Winter 2019, Winter 2018, Winter 2017, Winter 2016

Ordinary Differential Equations and Dynamical Systems: Summer 2017

MOOC Linear Algebra Driven by Data Science: 2020

Other.....

Development of the MOOC Linear Algebra Driven by Data Science

HafenCity Universität Hamburg

01/20–12/20

Other Qualifications and Skills

Language: German (native), English (fluent), French (advanced beginner)

OS: Windows

Text production: Word, \LaTeX

Computer algebra systems: GAP, MAPLE, MAXIMA

Machine Learning: Online courses of the Coursera specialisation Deep Learning

Programming: basic skills in Python