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". *Accepted for publication in the 32nd International Colloquium On Structural Information and Communications Complexity (SIROCCO 2025).* (2025). arXiv: 2305.06632.

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.

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*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

Reluctant Synchrony Breaking in Directed Hypernetworks: XLV Dynamics Days Europe (Thessaloniki, GR, 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

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-äquivarianten 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

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

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

DinAmicI 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	**São Carlos, Brazil**
Invitation by T. Pereira and E. Nijholt	*19/08/24–30/08/24*
Vrije Universiteit Amsterdam	**Amsterdam, Netherlands**
Invitation by C. Bick	*14/06/22–17/06/22*
Vrije Universiteit Amsterdam	**Amsterdam, Netherlands**
Invitation by B. Rink	*14/01/19–01/02/19*
Universidade do Porto	**Porto, Portugal**
PPP Projekt Heterokline Dynamik: Stabilität und Bifurkationen	*19/06/18–23/06/18*
Vrije Universiteit Amsterdam	**Amsterdam, Netherlands**
Invitation by B. Rink	*15/04/18–20/04/18*
Vrije Universiteit Amsterdam	**Amsterdam, Netherlands**
Invitation by B. Rink and E. Nijholt	*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