

# Sören von der Gracht, born Schwenker

## Contact Data

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## Current Position

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**Academic Senior Councillor (Akademischer Oberrat)** with Prof. B. Kovács

*Institute of Mathematics, Paderborn University*

09/25–present

The position is roughly equivalent to a non-tenured and non-tenure track assistant professorship with tasks in research and teaching.

## Education

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**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

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**Postdoctoral Researcher** with Prof. M. Dellnitz

*Institute of Mathematics, Paderborn University*

09/22–08/25

Project: Algorithms for Swarm Robotics: Distributed Computing meets Dynamical Systems

**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

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

**Equivariant Dynamics:** Genericity, Bifurcation Theory

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

## Publications\*

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### 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.

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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

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**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

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### Invited Conference Presentations.....

**Homogeneous Coupled Cell Systems with High-dimensional Internal Dynamics:** COUPLED 80 (virtual conference, 10/10/2025)

**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-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

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**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

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**03/25:** IOP Publishing Outstanding Reviewer Awards 2024

## Organized Events

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**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

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**COUPLED 80:** virtual workshop, 09/10/2025–10/10/2025

**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

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**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

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Society for Industrial and Applied Mathematics

## Referee

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Journal of Dynamics and Differential Equations

Journal of Physics A: Mathematical and Theoretical

Nonlinearity

SIAM Journal on Applied Dynamical Systems

Mathematical Reviews – MathSciNet

## Teaching

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### Independent Teaching.....

**Seminar Computational Dynamics**

Bachelor seminar for mathematics students at Paderborn University

*Winter 2025***Modellieren und Anwendungen: Dynamische Prozesse  
(Modelling and Applications: Dynamical Processes)**

Bachelor course for students in teacher training at Paderborn University

*Winter 2025***Modellieren und Anwendungen: Dynamische Prozesse  
(Modelling and Applications: Dynamical Processes)**

Bachelor course for students in teacher training at Paderborn University

*Winter 2024***Dynamische Systeme mit Netzwerkstruktur  
(Network Dynamical Systems)**

Master course for mathematics students at Paderborn University

*Winter 2024***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**

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

**OS:** Windows

**Text production:** Word,  $\text{\LaTeX}$

**Computer algebra systems:** GAP, MAPLE, MAXIMA

**Machine Learning:** Online courses of the Coursera specialisation Deep Learning

**Programming:** basic skills in Python