

# Rosa Lili Dora Preiß

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für Mathematik in den Naturwissenschaften  
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## Research Interests

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- Algebraic geometry of paths.
- Iterated-integral signatures, rough paths and regularity structures.
- Algebraic tools in stochastic analysis and mathematical physics.
- Renormalisation procedures and the amplituhedron.
- Invariant theory.
- Category theory and operads.
- Machine learning and data science.

## Education

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**Technische Universität Berlin**, Germany.

Dr.rer.nat. (PhD) in Mathematics. October 2021.

- Thesis topic: *Hopf algebras and non-associative algebras in the study of iterated-integral signatures and rough paths.*
- Supervisor: Professor Dr. Peter K. Friz.
- Reviewers: Professor Dr. Peter K. Friz, Professor Dr. Terry J. Lyons and Professor Dr. Kurusch Ebrahimi-Fard.

**Technische Universität Berlin**, Germany.

Master of Science (M. Sc.) in Mathematics, July 2016.

- Thesis Topic: *From Hopf Algebras to Rough Paths and Regularity Structures.*
- Supervisors: Professor Dr. Peter K. Friz and Professor Dr. Sylvie Paycha

**Julius-Maximilians-Universität Würzburg**, Germany.

Bachelor of Science (B. Sc.) in Mathematical Physics, January 2014.

- Thesis Topic: *On the Hydrodynamic Limit of a Symmetric Simple Exclusion Process.*
- Supervisor: Professor Dr. Christian Klingenberg

## Academic Career

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- Since October 2023      **Researcher**, Nonlinear Algebra Group, Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany. Supervisor: Bernd Sturmfels.
- November 2021 until September 2023      **Research Assistant**, AG Analysis, Institut für Mathematik, Universität Potsdam, Germany. Supervisor: Sylvie Paycha.
- Teaching activity:
- Exercise class for mathematics for physicists III (winter term 2021/22)
  - Exercise class for mathematics for physicists IV (summer term 2022)
  - Exercise class for groupoids and applications in mathematical physics (summer term 2022)
  - Exercise class for mathematics for physicists I (winter term 2022/23)
  - Exercise class for distribution theory (winter term 2022/23)
  - Lecture on Stieltjes integration and iterated integrals (summer term 2023)
  - Exercise class for mathematics for physicists II (summer term 2023)
- September 2016 until October 2021      **Research Assistant**, AG Stochastik und Finanzmathematik, Institut für Mathematik, Technische Universität Berlin, Germany. Supervisor: Peter K. Friz.
- Teaching activity:
- Exercise class for insurance mathematics (winter term 2016/17)
  - Tutorial for linear algebra for engineers (winter term 2016/17)
  - Tutorial for probability theory (summer term 2017)
  - Preparing exercise sheets for analysis for engineers (winter term 2017/18)
  - Exercise class / tutorial for probability theory (summer term 2018)
- Autumn 2018      **Research Assistant**, Nonlinear Algebra Group, Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany. Supervisor: Bernd Sturmfels.

## Papers

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- Rosa Preiß. **An algebraic geometry of paths via the iterated-integral signature**. arXiv:231.17886 [math.RA]. November 2023.
- Cristopher Salvi, Joscha Diehl, Terry Lyons, Rosa Preiß and Jeremy Reizenstein. **A structure theorem for streamed information**. Journal of Algebra, Volume 634, November 2023.
- Carlo Bellingeri, Peter K. Friz, Sylvie Paycha and Rosa Preiß. **Smooth rough paths, their geometry and algebraic renormalization**. Vietnam Journal of Mathematics, Volume 50, June 2022.
- Joscha Diehl, Rosa Preiß, Michael Ruddy and Nikolas Tapia. **The moving frame method for iterated-integrals: orthogonal invariants**. Foundations of Computational Mathematics, Volume 23, June 2022.
- Joscha Diehl, Terry Lyons, Rosa Preiß and Jeremy Reizenstein. **Areas of areas generate the shuffle algebra**. arXiv:2002.02338 [math.RA]. July 2021.
- Laura Colmenarejo and Rosa Preiß. **Signatures of paths transformed by polynomial maps**. Beiträge zur Algebra und Geometrie / Contributions to Algebra and Geometry, Volume 61, Issue 4, April 2020.
- Yvain Bruned, Ilya Chevyrev, Peter K. Friz and Rosa Preiß. **A Rough Path Perspective on Renormalization**. Journal of Functional Analysis, Volume 277, Issue 11, December 2019.

## Conferences attended

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*Mathematics of data streams: signatures, neural differential equations, and diffusion models.* Greifswald, Germany, April 8-13, 2024.

*Recent Developments in Rough Paths.* BI Norwegian Business School, Oslo, Norway, March 3-8, 2024.

12<sup>th</sup> *BMS Student Conference.* Technische Universität Berlin, Germany, February 21-23, 2024.

*A day of Algebraic Geometry.* Humboldt Universität zu Berlin, February 22, 2024.

*Positive Geometry in Particle Physics and Cosmology.* Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany, February 12-16, 2024.

18<sup>th</sup> *Oxford-Berlin Young Researchers Meeting on Applied Stochastic Analysis.* University of Oxford, United Kingdom, January 4-6, 2024. I gave a talk on **An algebraic geometry of paths via the iterated-integrals signature**.

*Mini-Workshop: Combinatorial and Algebraic Structures in Rough Analysis and Related Fields.* Mathematisches Forschungsinstitut Oberwolfach, Germany, November 26-December 2, 2023. I have been an organizer and gave a talk on **An algebraic geometry of (rough) paths**.

*Structural Aspects of Signatures and Rough Paths.* Center for Advanced Study, Oslo, Norway, August 28-September 1. I gave a talk on **An algebraic geometry of paths**.

17<sup>th</sup> *Annual Berlin-Oxford Young Researchers Meeting on Applied Stochastic Analysis.* Weierstrass Institute, Berlin, April 27-29, 2023.

16<sup>th</sup> *Oxford-Berlin Young Researchers Meeting on Applied Stochastic Analysis.* University of Oxford, United Kingdom, December 8-10, 2022. I gave a talk on **Smooth rough paths** (joint work with Carlo Bellingeri, Peter Friz and Sylvie Paycha).

*Rough Paths, Algebraic Structures and Machine Learning.* University of Adger, Kristiansand, Norway, October 20-21, 2022. I gave a talk on **Orthogonal and special linear invariants of paths via the iterated integral signature** (joint work with Joscha Diehl, Terry Lyons, Hao Ni, Micheal Ruddy, Jeremy Reizenstein and Nikolas Tapia).

*New interfaces of Stochastic Analysis and Rough Paths.* Banff International Research Station, Canada, September 4-9, 2022. I gave a talk on **Smooth rough paths** (joint work with Carlo Bellingeri, Peter Friz and Sylvie Paycha).

*SciCADE 2022.* University of Iceland, Reykjavík, July 25-29, 2022. I gave a talk on **Orthogonal and special linear invariants of paths via the iterated-integral signature** (joint work with Joscha Diehl, Terry Lyons, Hao Ni, Micheal Ruddy, Jeremy Reizenstein and Nikolas Tapia) in the minisymposium on *Geometric and algebraic perspectives in numerical integration*.

15<sup>th</sup> *Annual ERC Berlin-Oxford Young Researchers Meeting on Applied Stochastic Analysis.* Technische Universität Berlin and Humboldt Universität zu Berlin, Germany, May 12-14, 2022. I gave a talk on **Orthogonal and special linear invariants of paths via the iterated-integral signature: Overview and new developments** (joint work with Joscha Diehl, Micheal Ruddy, Jeremy Reizenstein and Nikolas Tapia).

*Rough algebra day.* Technische Universität Berlin, Germany, March 31, 2022. I gave a talk on **An algebraic geometry of paths via the iterated-integral signature**.

*Higher Structures Emerging from Renormalisation.* Erwin Schrödinger International Institute for Mathematics and Physics, Vienna, Austria, November 08 - 19, 2021. I gave a talk on **Adding rough paths: no problem as long as they are smooth** (joint work with Carlo Bellingeri, Peter K. Friz and Sylvie Paycha) and contributed a discussion of Felix Otto's talk on 'The structure group in regularity structures: avoiding trees'.

*Noncommutative algebra, probability and analysis in action.* Greifswald, Germany, September 20 - 25, 2021.

*The amplituhedron: algebra, combinatorics, and physics.* Zoom, April 08, 2021.

*Pathwise Stochastic Analysis and Applications.* Zoom, March 08 - 12, 2021.

*Cumulants in Stochastic Analysis.* Zoom, February 25 - 26, 2021.

*14<sup>th</sup> Annual ERC Oxford-Berlin Young Researchers Meeting on Applied Stochastic Analysis.* Zoom, February 10 - 12, 2021. I gave a talk on **Rotation-Reflection invariants of paths through signatures and moving frames** (joint work with Joscha Diehl, Michael Ruddy and Nikolas Tapia).

*Oberwolfach workshop: New Directions in Rough Path Theory (online meeting)..* Zoom, December 06 - 12, 2020. I gave a talk on **Areas of Areas generate the shuffle algebra** (joint work with Joscha Diehl, Terry Lyons and Jeremy Reizenstein).

*13<sup>th</sup> Annual ERC Berlin-Oxford Young Researchers Meeting on Applied Stochastic Analysis.* Zoom, June 08 - 10, 2020. I gave a talk on **Rotation Invariants of Paths Through Iterated Integral Signatures** (joint work with Joscha Diehl, Michael Ruddy and Nikolas Tapia).

*Young researchers between geometry and stochastic analysis.* Bergen, Norway, February 12-14, 2020.

*Workshop: Problems of roughness, geometry and random fluctuations.* Hausdorff Research Institute for Mathematics, Bonn, Germany, December 09 - 12, 2019. I gave a talk on **A Rough Path Perspective on Renormalization** (joint work with Yvain Bruned, Ilya Chevyrev and Peter K. Friz).

*12<sup>th</sup> Annual ERC Oxford-Berlin Young Researchers Meeting on Applied Stochastic Analysis.* University of Oxford, United Kingdom, December 04 - 06, 2019. I gave a talk on **Signatures of paths transformed by polynomial maps** (joint work with Laura Colmenarejo).

*Algebraic and Analytic Perspectives in the Theory of Rough Paths and Signatures.* Department of Mathematics, University of Oslo, Norway, November 14 - 15, 2019. I gave a talk on **Algebraic Methods for Signatures of Paths: Hopf, Zinbiel and Tortkara** (joint work with Laura Colmenarejo, Joscha Diehl, Terry Lyons and Jeremy Reizenstein).

*Opening Conference - Varieties, Polyhedra, Computation.* Freie Universität Berlin, Germany, October 07 - 11, 2019. Attended October 08 and 10.

*First Berlin-Leipzig workshop on Fluctuating Hydrodynamics.* Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany, and Institute of Mathematics, Freie Universität Berlin, Germany, August 26 - 30, 2019. Attended August 27 - 30.

*11<sup>th</sup> Annual ERC Berlin-Oxford Young Researchers Meeting on Applied Stochastic Analysis.* Weierstraß-Institut, Berlin, Germany, May 23 - 25, 2019.

*New Directions in Stochastic Analysis: Rough Paths, SPDEs and Related Topics - On the occasion of Professor Terry Lyons' 65th Birthday.* Zuse Institute Berlin, Germany, March 18 - 22, 2019.

*Berlin-Leipzig workshop in analysis and stochastics.* Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany, January 16 - 18, 2019. Attended January 17 - 18.

*Rough paths, regularity structures and combinatorial Hopf algebras.* University of Bergen, Norway, August 31 - September 01, 2018.

During the research seminar, I gave a talk on **Monoid Graded Rough Paths** (joint work with Alexander Schmeding).

*Summer School on Numerical Computing in Algebraic Geometry.* Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany, August 13 - 17, 2018. Attended August 13 - 15.

*Algebraic and geometric aspects of numerical methods for differential equations.* Institut Mittag-Leffler, Djursholm, Sweden, July 2 - 6, 2018.

*9<sup>th</sup> Annual ERC Berlin-Oxford Young Researchers Meeting on Applied Stochastic Analysis.* Weierstraß-Institut, Berlin, Germany, June 14 - 16, 2018.

*IST Austria Summer School in Probability and Mathematical Physics.* Institute of Science and Technology Austria, Klosterneuburg, Austria, June 4 - 8, 2018.

Minicourses:

- Sharp threshold phenomena via randomized algorithms, by Hugo Duminil-Copin.
- A BPHZ theorem for stochastic PDEs, by Martin Hairer.
- The Gaussian free field and Liouville quantum gravity, by Jason Miller.

*Berlin-Leipzig workshop in analysis and stochastics.* Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany, November 29 - December 01, 2017.

*18<sup>th</sup> Lluís Santaló Research Summer School: Algebraic and Combinatorial Methods in Stochastic Calculus.* Universidad Internacional Menéndez Pelayo, Santander, Spain, July 17 - 21, 2017.

Minicourses:

- Algebraic and combinatorial aspects in stochastic calculus, by Kurusch Ebrahimi-Fard and Frédéric Patras.
- Fluctuations of chaotic random variables: theoretical foundations and geometric applications, by Giovanni Peccati.
- Combinatorial Aspects of Free Probability and Free Stochastic Calculus, by Roland Speicher.
- Rough paths, regularity structures and renormalisation, by Lorenzo Zambotti.

*7<sup>th</sup> Annual ERC Berlin-Oxford Young Researchers Meeting on Applied Stochastic Analysis.* Weierstraß-Institut, Berlin, Germany, May 18 - 20, 2017.

*Workshop on Algebraic Renormalisation of Regularity Structures.* Department of Mathematics, University of Bergen, Norway, April 03 - 07, 2017. I contributed a short summary talk on the subsections *Algebraic renormalisation* and *Recursive Formulae* of the paper *Algebraic renormalisation of regularity structures* by Yvain Bruned, Martin Hairer and Lorenzo Zambotti.

*Analytic Aspects of Renormalization.* Minicourse given by Ajay Chandra (University of Warwick). Technische Universität Berlin, Germany, September 26 - 29, 2016.

*Meeting on Applied Stochastic Analysis.* Mathematics Department, University of Oxford, United Kingdom, December 8 - 10, 2016.

I gave a talk on **A Rough Path Perspective on Renormalization** (joint work with Yvain Bruned, Ilya Chevyrev and Peter K. Friz).

5<sup>th</sup> *Annual ERC Berlin-Oxford Young Researchers Meeting on Applied Stochastic Analysis*. Weierstraß-Institut & Technische Universität Berlin, Berlin, Germany, August 12 - 15, 2016.

*Paths to, from and in renormalization*. At the confluence of rough paths, algebra, analysis and geometry. Universität Potsdam, Germany, February 8 - 12, 2016.

4<sup>th</sup> *Annual ERC Berlin-Oxford Young Researchers Meeting on Applied Stochastic Analysis*. Weierstraß-Institut, Berlin, Germany, December 7 - 9, 2015.

### Language Skills

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German (native), English (advanced), French (elementary).

Berlin, 12 May 2024