Christian Brennecke

Department of Mathematics
RWTH Aachen University

Email: christian *dot* brennecke *at* rwth-aachen *dot* de
Web: www.iam.uni-bonn.de/users/brennecke/home/

Personal Information

Citizenship: German
Languages: German (mother-tongue), English (fluent), French (intermediate)

Research Interests

Mathematical quantum and statistical physics, analysis, probability theory

Employment

Oct. 2026 - present: Professor (*Chair of Geometry and Probability for High Dimensions*), RWTH Aachen University
Oct. 2021 - Sep. 2026: Professor (*Bonn Junior Fellow*), University of Bonn
July 2018 - June 2021: Benjamin Peirce Fellow, Harvard University

Education

July 2018: Doctorate (Dr. sc. nat.) in mathematics, University of Zurich
Advisor: Prof. Dr. Benjamin Schlein
Sep. 2015: M.Sc. in mathematics with distinction, ETH Zurich
July 2013: B.Sc. in mathematics, Free University of Berlin
Sep. 2011: B.Sc. in physics, RWTH Aachen University

Honors

July 2025: Frontiers of Science Award, ICBS 2025, Beijing
Aug. 2021: Invited speaker (many-body quantum mechanics session), ICMP 2021, Geneva
Aug. 2021: Certificate of Teaching Excellence, Harvard University
May 2021: Certificate of Teaching Excellence, Harvard University
Oct. 2018: Doctoral thesis awarded with distinction, University of Zurich
June 2016: Willi-Studer Prize, ETH Zurich

Papers

[27] C. Brennecke. On the Leading Order Term of the Lattice Yang-Mills Free Energy. *J. Stat. Phys.* **93**, 83 (2026).

[26] N. Behrmann, C. Brennecke, S. Rademacher. Exponential Control of Excitations for Trapped BEC in the Gross-Pitaevskii Regime. *Lett. Math. Phys.* **115**, 91 (2025).

[25] C. Brennecke, A. Schertzer. On the Replica Symmetry of a Variant of the Sherrington-Kirkpatrick Spin Glass. *Electron. Commun. Probab.* **30**, article nr. 46 (2025).

[24] C. Brennecke, W. Kroschinsky. Derivation of the Gross-Pitaevskii Dynamics through Renormalized Excitation Number Operators. *Forum Math. Sigma* **13** (2025).

[23] C. Brennecke, A. Schertzer, C. Van Dam. Spin Covariance Fluctuations in the SK Model at High Temperature. *Electron. Commun. Prob.* **30**, paper no. 9 (2025).

[22] C. Brennecke, M. Brooks, C. Caraci, J. Oldenburg. A Short Proof of Bose-Einstein Condensation in the Gross-Pitaevskii Regime and Beyond. *Ann. Henri Poincaré* **26** (2024).

[21] C. Brennecke, J. Lee, P. T. Nam. Second Order Expansion of Gibbs State Reduced Densities in the Gross-Pitaevskii Regime. *SIAM J. Math. Anal.* **56**, Issue 4 (2024).

[20] C. Brennecke, C. Xu, H.-T. Yau. Operator Norm Bounds on the Correlation Matrix of the SK Model at High Temperature. Preprint: arXiv:2307.12535.

[19] C. Brennecke, A. Schertzer, C. Xu, H.-T. Yau. The Two Point Function of the SK Model without External Field at High Temperature. *Prob. Math. Phys.* **5**, no. 1 (2024).

[18] A. Adhikari, C. Brennecke, C. Xu, H.-T. Yau. Spectral Gap Estimates for Mixed p-Spin Models at High Temperature. *Probab. Theory Relat. Fields* **189** (2024).

[17] C. Brennecke. Bogoliubov Theory for Ultra Dilute Bose Gases. In: M. Correggi, M. Falconi (eds), Quantum Mathematics II. INdAM 2022, *Springer INdAM Series* **58**, Springer, Singapore (2023).

[16] C. Brennecke. The Low Energy Spectrum of Trapped Bosons in the Gross-Pitaevskii Regime. *J. Math. Phys.* **63** (2022).

[15] C. Brennecke, H.-T. Yau. The Replica Symmetric Formula for the SK Model Revisited. *J. Math. Phys.* **63** (2022).

[14] C. Brennecke, B. Schlein, S. Schraven. Bogoliubov Theory for Trapped Bosons in the Gross-Pitaevskii Regime. *Ann. Henri Poincaré* **23**, 1583-1658 (2022).

[13] C. Brennecke, M. Caporaletti, B. Schlein. Excitation Spectrum for Bose Gases beyond the Gross-Pitaevskii Regime. *Rev. Math. Phys.* **34**, no. 09 (2022).

[12] C. Brennecke, P. von Soosten. On the mean-field equations for ferromagnetic spin systems. *Lett. Math. Phys.* **111**, 108 (2021).

[11] C. Brennecke, B. Schlein, S. Schraven. Bose-Einstein Condensation with Optimal Rate for Trapped Bosons in the Gross-Pitaevskii Regime. *Math. Phys. Anal. Geom.* **63**, 12 (2022).

[10] A. Adhikari, C. Brennecke, P. von Soosten, H.-T. Yau. Dynamical Approach to the TAP Equations for the Sherrington-Kirkpatrick Model. *J. Stat. Phys.* **183** (2021).

[9] A. Adhikari, C. Brennecke, B. Schlein. Bose-Einstein Condensation Beyond the Gross-Pitaevskii Regime. *Ann. Henri Poincaré* **22**, 1163-1233 (2021).

[8] A. Adhikari, C. Brennecke. Free Energy of the Quantum Sherrington-Kirkpatrick Spin-Glass Model with Transverse Field. *J. Math. Phys.* **61** (2020).

[7] C. Boccato, C. Brennecke, S. Cenatiempo, B. Schlein. Optimal Rate for Bose-Einstein Condensation in the Gross-Pitaevskii Regime. *Comm. Math. Phys.* **376**, 1311-1395 (2020).

[6] C. Boccato, C. Brennecke, S. Cenatiempo, B. Schlein. Bogoliubov Theory in the Gross-Pitaevskii Limit. *Acta Mathematica* **222**, no. 2, 219-335 (2019).

[5] C. Brennecke, P. T. Nam, M. Napiórkowski, B. Schlein. Fluctuations of N-particle quantum dynamics around the nonlinear Schrödinger equation. *Ann. Inst. Henri Poincaré C - Anal. Non Linéaire* **36**, no. 5, 1201-1235 (2019).

[4] C. Boccato, C. Brennecke, S. Cenatiempo, B. Schlein. The excitation spectrum of Bose gases interacting through singular potentials. *J. Eur. Math. Soc.* **22**, no. 7, (2020).

[3] C. Boccato, C. Brennecke, S. Cenatiempo, B. Schlein. Complete Bose-Einstein condensation in the Gross-Pitaevskii regime. *Comm. Math. Phys.* **359**, no. 3, 975–1026 (2018).

[2] C. Brennecke, B. Schlein. Gross-Pitaevskii Dynamics for Bose-Einstein Condensates. *Analysis & PDE* **12**, no. 6, 1513-1596 (2019).

[1] C. Brennecke, A. Linke, C. Merdon, J. Schöberl. Optimal and Pressure-independent L^2 Velocity Error Estimates for a Modified Crouzeix-Raviart Stokes Element with BDM Reconstructions. *J. Comp. Math.* **33**, no. 2, 191-208 (2015).

Talks

- 12/2026: Probability and Stochastic Analysis Workshop, SISSA, Trieste
- 10/2026: TRR 352 Mind the Gap 2026 Workshop, Kochel am See
- 06/2026: SPP2265: 5th Annual Conference (plenary speaker), DLR, Cologne
- 04/2026: Analysis and Mathematical Physics Seminar, Virginia Tech
- 03/2026: Probability, Statistical Mechanics and QFT Seminar, SISSA, Trieste
- 02/2026: Oberseminar Stochastik, TU Darmstadt
- 12/2025: Mathematical Physics Seminar, University of Geneva
- 11/2025: Quantum Many-Body Systems Workshop, ESI, University of Vienna

- 07/2025: Frontiers of Science Award Lecture, ICBS 2025, Beijing
- 06/2025: Effective theories in classical and quantum particle systems, SISSA, Trieste
- 05/2025: PDE and Mathematical Physics Seminar, University of Zurich
- 01/2025: SMAQ Seminar, GSSI L'Aquila
- 12/2024: MathPhys Analysis Seminar, ISTA
- 12/2024: Vienna Probability Seminar, ISTA / University of Vienna / TU Vienna
- 07/2024: Second Joint AMS-UMI Meeting, Università degli Studi di Palermo
- 05/2024: Mathematical Challenges in Quantum Mechanics - Online Seminars, GSSI / PoliMi / LMU / Sapienza / Copenhagen
- 04/2024: Frontiers in Analysis and Mathematical Physics, Seoul National University
- 11/2023: DACO Seminar, ETH Zurich
- 11/2023: Munich-Copenhagen-Santiago Seminar in Mathematical Physics, LMU Munich, University of Copenhagen and Pontificia Universidad Católica de Chile
- 11/2023: Mathematical Physics Seminar, University of Tübingen
- 04/2023: Theory of Duality Seminar, University of Warsaw
- 03/2023: HCM Retreat, Bad Breisig
- 02/2023: Cambridge Probability Seminar, University of Cambridge
- 11/2022: A Geometric Fairytale full of Spectral Gaps and Random Fruit (mini-workshop), Mathematisches Forschungsinstitut Oberwolfach
- 03/2022: INdAM Quantum Meetings trimester program (mini course *Bogoliubov Theory for Ultra-Dilute Bose Gases*, three-lectures), Politecnico di Milano
- 11/2021: Mathematical physics and probability theory seminar, Texas A&M
- 11/2021: Seminar on Mathematics and Physics, University of Bonn / University of Cologne
- 08/2021: ICMP 2021 (many-body quantum mechanics session talk), Geneva
- 06/2021: Rhein-Main-Kolloquium Frankfurt, Goethe University Frankfurt
- 04/2021: Waterloo probability seminar, University of Waterloo
- 03/2021: Seminar in Probability Theory and Statistics, University of Basel
- 03/2021: Probability seminar, Northwestern University and University of Minnesota
- 02/2021: 38th Western States Meeting in Mathematical Physics, Caltech

- 01/2021: Theory of Duality Seminar, University of Warsaw
- 12/2020: GAuS online seminar, ETH Zurich, IST Austria and TU Braunschweig
- 12/2020: Analysis und Zufall seminar, TU Munich
- 05/2020: Seminar in Probability Theory and Statistics, University of Basel
- 10/2019: Analysis Seminar, University of Rochester
- 07/2019: Tübingen-Zürich Meeting in Mathematical Physics, University of Tübingen
- 05/2019: 121st Statistical Mechanics Conference, Rutgers University
- 01/2019: Spectral Methods in Mathematical Physics, Institut Mittag-Leffler, Stockholm
- 09/2018: Many-Body Quantum Mechanics workshop, CRM Montréal
- 04/2018: Calculus of variations and applications seminar, LMU Munich
- 02/2018: Mathematical Challenges in Quantum Mechanics workshop (contributed talk), Sapienza University of Rome
- 12/2017: Calculus of variations and applications seminar, LMU Munich
- 06/2017: GRK 1838 seminar, University of Stuttgart (extra-curricular talk)

Teaching

- lectures: *Introduction to Constructive Quantum Field Theory 3* (Bonn, spring 2026), *Introduction to Constructive Quantum Field Theory 2* (Bonn, fall 2025), *Introduction to Constructive Quantum Field Theory 1* (Bonn, spring 2025), *Topics in Many-Body Quantum Mechanics* (Bonn, fall 2021, spring 2023 & fall 2024), *Advanced Real Analysis* (Harvard, spring 2019 & 2021), *Introductory Real Analysis* (Harvard, spring 2021), *Probability Theory* (Harvard, spring 2020), *Measure, Integration and Banach Spaces* (Harvard, fall 2019 & 2020), *Vector Space Methods for Differential Equations* (Harvard, spring 2019 & 2020), *Dynamical and Spectral Properties of Large Many-Body Quantum Systems* (Harvard, fall 2018)
- seminars: *Introduction to Spin Glasses and the Parisi Formula* (Bonn, spring 2022), *Introduction to a Renormalization Group Method* (Bonn, fall 2022), *Topics in Mean Field Spin Glasses* (Bonn, fall 2023), *Quantum Mechanics for Mathematicians: An Introduction* (Bonn, spring 2024)

Student Supervision

- doctoral students: Jakob Wilden (Oct. 2026 - present)
- master theses: *Yang-Mills Type Heat Equations with Random Distributional Initial Data* by Nicoló Vallini (Bonn, 09/2026), *On the Partition Function of Lattice Yang-Mills Theories* by William Clark (Bonn, 09/2026), *BEC in GP with Neumann Boundary Conditions* by Noah Koopmann (Bonn, 05/2026), *BEC for Ultra Dilute Bose Gases* by Jakob Wilden (Bonn, 05/2025), *Exponential Control of Excitations in Bose-Einstein Condensates in the GP Limit* by Nils Behrmann (Bonn, 09/2024), *Second Order Energy Upper Bounds on Dilute Bose Gases* by Utku Kemal Yüzbasioglu (Bonn, 08/2024), *Free Energy Fluctuations for the SK Model using the TAP Approach* by Benjamin Nettesheim (Bonn, 06/2024), *Hanen's Theorem for the SK Model* by Chen Van Dam (Bonn, 04/2024)
- bachelor theses: *Construction of Free Quantum Fields* by Elias Münch (Bonn, 04/2024)
- Erasmus internship: Davide Desio (04/2024 - 06/2024, University of Milan)

Postdocs

- Dr. Wilhelm Kroschinsky (Bonn, 08/2023 - 08/2025)
- Dr. Adrien Schertzer (Bonn, 01/2024 - 04/2025)

Service

- co-organizer *Semester Program: The Mathematical Roads to QFT*, Spring 2026, Research Institute for Mathematical Sciences, Kyoto University
- fall 2024 - present: member of the HSM Executive Committee
- co-organizer *Hausdorff School: Recent Advances in Quantum and Statistical Mechanics*, June 26-30, 2023, University of Bonn
- spring 2023 - spring 2026: co-organizer Mathematical Physics Seminar, University of Bonn
- fall 2022 - spring 2024: co-organizer Hausdorff Colloquium, University of Bonn
- fall 2019 - spring 2021: co-organizer RMT and Probability Seminar, Harvard University
- referee work for *Advances in Mathematics, Analysis & PDE, Annales of Applied Probability, Annales Henri Poincaré, Annals of Mathematics, Annals of PDE, Archive for Rational Mechanics and Analysis, Communications in Mathematical Physics, Communications on Pure and Applied Mathematics, Duke Mathematical Journal, Electronic Communications in Probability, Forum of Mathematics Pi, Forum of Mathematics Sigma, Inventiones mathematicae, Journal of Applied Probability, Journal of Functional Analysis, Journal of Mathematical Physics, Journal de Mathématiques Pure et Appliquées, Journal of Statistical Physics, Letters in Mathematical Physics, Probability and Mathematical Physics, Probability Theory and Related Fields, Publications mathématiques de l'IHES, zbMATH Open, DFG*

Outreach

- 05/2022: public lecture *Bose-Einstein Kondensation des schwach wechsel-wirkenden Bose Gases* at *Dies Academicus*, University of Bonn
- 04/2022: public lecture *Kondensation von kleinsten Teilchen - die Vorhersagen von Bose-Einstein und was wir beweisen können* at *Fünfte Bonner Mathenacht aus Bonn* organized by the Hausdorff Center for Mathematics, University of Bonn