

Melchior Wirth

Curriculum Vitae

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Personal Information

Name Melchior Wirth
Date of birth April 24, 1990
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Education and Positions

since 2022 FWF Esprit Fellow
since 2020 Postdoc ISTA, Maas Group
2015–2020 PhD studies mathematics, FSU Jena
Dr. rer. nat. March 2020, Final grade *summa cum laude*
PhD thesis: *Entropic Gradient Flow Structure of Quantum Markov Semigroups*
Reviewers: Daniel Lenz, Jan Maas, Eric Carlen
2014–2015 Master studies mathematics, FSU Jena
Master of Science October 2015, Final grade 1,0
Master's thesis: *Uniqueness of form extensions and domination of semigroups*
Supervisor: Daniel Lenz (FSU Jena)
2013–2014 Master studies mathematics, WWU Münster
2011–2013 Bachelor studies mathematics, FSU Jena
Bachelor of Science August 2013, Final grade 1,0
Bachelor's thesis: *Does diffusion determine the graph structure?*
Supervisor: Daniel Lenz (FSU Jena)
2010–2011 Bachelor's studies physics, FSU Jena

Research Interests

- classical and quantum Markov semigroups and Dirichlet forms
- analysis on graphs
- quantum information theory

Publications and Preprints

Peer-reviewed Publications

1. Christensen–Evans theorem and extensions of GNS-symmetric quantum Markov semigroups, *Journal of Functional Analysis*, accepted.
arXiv:2203.00341
2. Modular Completely Dirichlet forms as Squares of Derivations, *International Mathematics Research Notices. IMRN*, accepted.
arXiv:2307.04502
3. (with C. Rouzé, H. Zhang) Quantum Talagrand, KKL and Friedgut’s theorems and the learnability of quantum Boolean functions. *Communications in Mathematical Physics*, 2024.
doi: 10.1007/s00220-024-04981-0, arXiv:2209.07279
4. (with M. Vernooij) Derivations and KMS-Symmetric Quantum Markov Semigroups. *Communications in Mathematical Physics*, 2023.
doi: 10.1007/s00220-023-04795-6, arXiv:2303.15949
5. (with B. Hua, M. Keller, M. Schwarz) Sobolev-Type Inequalities and Eigenvalue Growth on Graphs with Finite Measure. *Proceedings of the American Mathematical Society*, 2023.
doi: 10.1090/proc/14361, arXiv:1804.08353
6. (with L. Dello Schiavo) Ergodic Decompositions of Dirichlet Forms under Order Isomorphisms. *Journal of Evolution Equations*, 2023.
doi: 10.1007/s00028-022-00859-7, arXiv:2109.00615
7. (with H. Zhang) Curvature-dimension conditions for symmetric quantum Markov semigroups. *Annales Henri Poincaré*, 2022.
doi: 10.1007/s00023-022-01220-x, arXiv:2105.08303
8. Stability of Kac regularity under domination of quadratic forms. *Advances in Operator Theory*, 2022.
doi: 10.1007/s43036-022-00199-w, arXiv:1709.04164
9. A Dual Formula for the Noncommutative Transport Distance. *Journal of Statistical Physics*, 2022.
doi: 10.1007/s10955-022-02911-9, arXiv:2104.11923
10. (with H. Zhang) Complete Gradient Estimates of Quantum Markov Semigroups. *Communications in Mathematical Physics*, 2021.
doi: 10.1007/s00220-021-04199-4, arXiv:2007.13506
11. (with D. Lenz, T. Weinmann) Self-Adjoint Extensions of Bipartite Hamiltonians. *Proceedings of the Edinburgh Mathematical Society*, 2021.

doi: 10.1017/S0013091521000080, arXiv:1912.03670

12. (with D. Lenz, M. Schmidt) Uniqueness of form extensions and domination of semigroups. *Journal of Functional Analysis*, 2021.
doi: 10.1016/j.jfa.2020.108848, arXiv:1608.06798
13. (with C. Richter) Tilings of convex sets by mutually incongruent equilateral triangles contain arbitrarily small tiles. *Discrete and Computational Geometry*, 2020.
doi: 10.1007/s00454-019-00061-6, arXiv:1711.08903
14. (with D. Lenz, M. Schmidt) Domination of quadratic forms. *Mathematische Zeitschrift*, 2020.
doi: 10.1007/s00209-019-02440-4, arXiv:1711.07225
15. (with M. Erbar, J. Maas) On the geometry of geodesics in discrete optimal transport. *Calculus of Variations and Partial Differential Equations*, 2019.
doi: 10.1007/s00526-018-1456-1, arXiv:1805.06040
16. (with M. Keller, D. Lenz, M. Schmidt) Diffusion determines the recurrent graph. *Advances in Mathematics*, 2015.
doi: 10.1016/j.aim.2014.10.003, arXiv:1405.3256

Preprints

17. (with F. Münch, H. Zhang) Intertwining Curvature Bounds for Graphs and Quantum Markov Semigroups
arXiv:2401.05179
18. (with D. Lenz, M. Keller, M. Schmidt, M. Schwarz) Boundary representations of intermediate forms between a regular Dirichlet form and its active main part
arXiv:2301.01035
19. The Differential Structure of Generators of GNS-symmetric Quantum Markov Semigroups
arXiv:2207.09247
20. A Noncommutative Transport Metric and Symmetric Quantum Markov Semigroups as Gradient Flows of the Entropy
arXiv:1808.05419
21. (with D. Lenz, M. Schmidt) Geometric properties of Dirichlet forms under order isomorphisms
arXiv:1801.08326

Funding

- 2022–2025 FWF Esprit Fellowship, project ESP 156 *Gradient flow techniques for quantum Markov semigroups*
Total funding sum: 294.015,98 €
- 2017–2020 PhD scholarship of German Academic Scholarship Foundation (Studienstiftung des deutschen Volkes)
2016 Oberwolfach Leibniz Graduate Student (OWLG)
- 2013–2015 Scholarship of German Academic Scholarship Foundation (Studienstiftung des deutschen Volkes)

Prizes

- 2021 PhD prize of FSU Jena
- 2016 Prize for master's thesis by president of FSU Jena
- 2016 Prize for master's thesis at DMV students' conference

Teaching

Courses as Instructor

- Winter 2023/24 Trace inequalities and quantum entropies (University of Paderborn, in German)
- Winter 2022/23 Linear algebra for life scientists (ISTA, in English)
- Summer 2022 Trace inequalities and quantum entropies (ISTA, with Haonan Zhang, in English)

Courses as Teaching Assistant

- Winter 2019/20 Analysis III (Jena, in German)
- Winter 2015/16 Functional Analysis II (Jena, in German)
- Summer 2015 Ordinary Differential Equations (Jena, in German)
- Summer 2013 Functional Analysis (Jena, in German)
- Winter 2012/13 Analysis III (Jena, in German)
- Summer 2012 Analysis II (Jena, in German)

Co-Supervision

- Timon Weinmann Bachelor's thesis on 'Self-adjoint realizations of Hamiltonians of coupled systems', 2019 (joint supervision with D. Lenz)
- Sebastian Uschmann Master's thesis on 'Cohomology of Dirichlet forms', 2018 (joint supervision with D. Lenz)

Collaborators

- Cédric Arhancet (Lycée général Lapérouse Albi, work in progress)
- Martijn Caspers (TU Delft, work in progress)
- Lorenzo Dello Schiavo (Institute of Science and Technology Austria)
- Matthias Erbar (University of Bonn)
- Bobo Hua (Fudan University)
- Matthias Keller (University of Potsdam)
- Rahul Kumar (IIT Madras, Chennai, work in progress)
- Daniel Lenz (University of Jena)
- Jan Maas (Institute of Science and Technology Austria)
- Shreya Mehta (Imperial College London, work in progress)
- Florentin Münch (Max Planck Institute of Mathematics in the Natural Sciences, Leipzig)
- Christian Richter (University of Jena)
- Cambyse Rouzé (TU Munich)
- Marcel Schmidt (University of Jena)

- Michael Schwarz (University of Potsdam)
- Matthijs Vernooij (TU Delft)
- Timon Weinmann (St. Petersburg State University)
- Haonan Zhang (Institute of Science and Technology Austria)

Community Service

Reviewing

- Advances in Operator Theory
- Annales Henri Poincaré
- Archive for Rational Mechanics and Analysis
- Discrete and Computational Geometry
- Discrete and Continuous Dynamical Systems
- Forum of Mathematics, Sigma
- Geometric and Functional Analysis (GAFA)
- Infinite Dimensional Analysis, Quantum Probability and Related Topics
- International Mathematics Research Notices
- Journal of Functional Analysis
- Journal of Mathematical Analysis and Applications
- Journal of Theoretical Probability
- Studia Mathematica
- MathReviews (Mathscinet)
- zblmath

Co-Organized Workshops

- 03/2018 (with Daniel Lenz, Ilya Pavlyukevich) One Day Workshop *Nonlocal Models in Analysis and Probability*, FSU Jena
- 08/2017 (with Michael Schwarz) Young Researchers' Symposium at Conference *Analysis and Geometry on Graphs and Manifolds*, University of Potsdam

Talks

Invited Talks

- 03/2024 Conference 'Open Quantum Systems'
Toulouse Mathematical Institute, France
Title: *Generators of Symmetric Quantum Markov Semigroups*
- 01/2024 Seminar 'Complex Quantum Systems'
University of Paderborn, Germany
Title: *Symmetric Quantum Markov Semigroups and Their Generators*
- 07/2023 Workshop 'Infinite dimensional quantum Markov semigroups'
University of Tübingen, Germany

- Title: *Generators of GNS-Symmetric Quantum Markov Semigroups*
- 06/2023 Workshop ‘Noncommutative Harmonic Analysis and Quantum Information’
Mittag Leffler Institute Stockholm, Sweden
Title: *Logarithmic Sobolev inequalities for type III von Neumann algebras*
- 05/2023 Workshop ‘Concentration inequalities for quantum measurements and non commutative functional inequalities’
Toulouse Mathematical Institute, France
Title: *Logarithmic Sobolev inequalities – beyond matrix algebras and tracial symmetry*
- 11/2022 Research Seminar ‘Analysis, Dynamical Systems and Mathematical Physics’
Friedrich Schiller University Jena, Germany
Title: *Generators of GNS-symmetric Quantum Markov Semigroups*
- 09/2022 Workshop ‘Optimal Transport on Quantum Structures’
Rényi Institute Budapest, Hungary
Title: *The Differential Structure of Generators of GNS-Symmetric Quantum Markov Semigroups*
- 08/2022 One-Day Workshop ‘Noncommutative Integration’
TU Delft, Netherlands
Title: *A Christensen–Evans theorem for GNS-symmetric quantum Markov semigroups*
- 12/2021 Seminar ‘Functional Analysis, Operator Theory and Dynamical Systems’
online, jointly organized by Universities of Jena, Leipzig and Postdam
Title: *Curvature-dimension conditions for quantum Markov semigroups*
- 02/2021 Workshop ‘Entropy Inequalities, Quantum Information and Quantum Physics’
Institute for Pure and Applied Mathematics (IPAM), University of California, Los Angeles, USA
Title: *From Entropic Curvature Bounds to Logarithmic Sobolev Inequalities*
- 01/2021 PDE Afternoon of SFB ‘Taming Complexity in Partial Differential Systems’
University Vienna, Austria
Title: *Entropic gradient flow structure of quantum Markov semigroups*
- 01/2021 Workshop ‘Geometry, Dynamics and Spectrum of Operators on Discrete Spaces’
Mathematisches Forschungsinstitut Oberwolfach (MFO), Germany
Title: *Logarithmic Sobolev inequalities for quantum Markov semigroups – an optimal transport approach*
- 11/2020 MathPhys Analysis Seminar
Institute of Science and Technology Austria (ISTA)

- Title: *Gradient estimates for quantum Markov semigroups and return to equilibrium*
- 06/2019 Seminar of Research Training Group 'Energy, Entropy, and Dissipative Dynamics'
RWTH Aachen, Germany
Title: *Entropic gradient flow structure of quantum Markov semigroups*
- 07/2018 Jena-Leipzig-Seminar
Friedrich Schiller University Jena, Germany
Title: *The Geometry of Geodesics in Discrete Optimal Transport*
- 03/2018 Closing workshop Research Training Group 'Quantum and Gravitational Fields'
Friedrich Schiller University Jena, Germany
Title: *The Heat Flow as Gradient Flow of the Entropy*
- 03/2017 Workshop 'Interface between Commutative and Non-Commutative Stochastic Analysis'
Hokkaido University, Sapporo, Japan
Title: *A transport metric for Dirichlet forms and gradient flows of the entropy*
- 03/2017 Workshop 'Dirichlet Forms and Their Geometry'
Tohoku University, Sendai, Germany
Title: *Geometric properties of Dirichlet forms under order isomorphisms*
- 01/2017 Seminar 'Discrete spectral geometry'
University of Potsdam, Germany
Title: *A transport metric for non-local Dirichlet forms and gradient flows of the entropy*
- 11/2016 Workshop 'Heat kernels, stochastic processes and functional inequalities'
Mathematisches Forschungsinstitut Oberwolfach (MFO), Germany
Title: *Geometric properties of Dirichlet forms under order isomorphisms*
- 09/2016 Summer school 'Spectral Theory, Differential Equations and Probability'
University of Mainz, Germany
Title: *Does Diffusion Determine the Geometry?*
- 01/2016 Workshop 'Spectral Geometry'
University of Potsdam, Germany
Title: *Domination of semigroups and uniqueness of form extensions*
- 01/2015 Workshop 'New Directions in Mathematical Physics and beyond'
Friedrich Schiller University Jena, Germany
Title: *Does diffusion determine the graph structure?*
- [Contributed Talks](#)
- 10/2022 Workshop 'OTET 10 – Noncommutative Ergodic Theory'
Christian-Albrecht University of Kiel, Germany
Title: *Generators of GNS-Symmetric Quantum Markov Semigroups*

- 07/2022 Conference ‘New Challenges in Operator Semigroups’
 St. John’s College, University of Oxford, United Kingdom
 Title: *Generators of GNS-symmetric quantum Markov semigroups*
- 05/2020 ‘Canadian Operator Symposium’ (CoSy)
 Fields Institute Toronto, Canada
 Title: *Quantum Markov Semigroups as Gradient Flows of the Entropy*
- 06/2019 Conference ‘Geometric aspects of harmonic analysis and spectral theory’
 Technion – Israel Institute of Technology, Haifa, Israel
 Title: *Sobolev-Type Inequalities and Eigenvalue Growth on Graphs with Finite Measure*
- 08/2017 Summer school ‘Analysis and Theoretical Numerical Analysis’
 Siegmundsburg, Germany
 Title: *Laplacians and isometries of metric measure spaces*
- 03/2017 Winter school ‘From Particle Dynamics to Gradient Flows’
 TU Kaiserslautern, Germany
 Title: *Dirichlet forms and gradient flows of the entropy*
- 12/2016 Workshop ‘Operator Theory and Indefinite Inner Product Spaces’
 TU Vienna, Austria
 Title: *Uniqueness of form extensions and domination of semigroups*
- 07/2016 Summer school ‘Analysis and Theoretical Numerical Analysis’
 Siegmundsburg, Germany
 Title: *Uniqueness of form extensions via domination of semigroups*
- 07/2016 Students’ conference of the Deutschen Mathematikervereinigung (DMV)
 TU Berlin, Germany
 Title: *Uniqueness of form extensions on L^2 spaces*