

# Curriculum Vitae

Melchior Wirth

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## Personal Information

Name Melchior Wirth  
Date and place of birth April 24, 1990, Dresden, Germany  
Nationality German  
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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

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## Research interests

- classical and quantum Markov semigroups and Dirichlet forms
- optimal transport
- quantum information theory

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## Publications and preprints

### Peer-reviewed publications

1. (with B. Hua, M. Keller, M. Schwarz) Sobolev-Type Inequalities and Eigenvalue Growth on Graphs with Finite Measure. *Proceedings of the American Mathematical Society*, accepted.
2. (with L. Dello Schiavo) Ergodic Decompositions of Dirichlet Forms under Order Isomorphisms, *Journal of Evolution Equations*, 2023.
3. (with H. Zhang) Curvature-dimension conditions for symmetric quantum Markov semigroups, *Annales Henri Poincaré*, 2022.
4. Stability of Kac regularity under domination of quadratic forms, *Advances in Operator Theory*, 2022.
5. A Dual Formula for the Noncommutative Transport Distance. *Journal of Statistical Physics*, 2022.
6. (with H. Zhang) Complete Gradient Estimates of Quantum Markov Semigroups. *Communications in Mathematical Physics*, 2021.
7. (with D. Lenz, T. Weinmann) Self-Adjoint Extensions of Bipartite Hamiltonians. *Proceedings of the Edinburgh Mathematical Society*, 2021.
8. (with D. Lenz, M. Schmidt) Uniqueness of form extensions and domination of semigroups. *Journal of Functional Analysis*, 2021.
9. (with C. Richter) Tilings of convex sets by mutually incongruent equilateral triangles contain arbitrarily small tiles. *Discrete and Computational Geometry*, 2020.
10. (with D. Lenz, M. Schmidt) Domination of quadratic forms. *Mathematische Zeitschrift*, 2020.
11. (with M. Erbar, J. Maas) On the geometry of geodesics in discrete optimal transport. *Calculus of Variations and Partial Differential Equations*, 2019.
12. (with M. Keller, D. Lenz, M. Schmidt) Diffusion determines the recurrent graph. *Advances in Mathematics*, 2015.

### Preprints

13. (with M. Vernooij) Derivations and KMS-Symmetric Quantum Markov Semigroups, *arXiv:2303.15949*.
14. (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*.
15. (with C. Rouzé, H. Zhang) Quantum Talagrand, KKL and Friedgut's theorems and the learnability of quantum Boolean functions, *arXiv:2209.07279*.
16. The Differential Structure of Generators of GNS-symmetric Quantum Markov Semigroups, *arXiv:2207.09247*.
17. Christensen–Evans theorem and extensions of GNS-symmetric quantum Markov semigroups, *arXiv:2203.00341*.
18. A Noncommutative Transport Metric and Symmetric Quantum Markov Semigroups as Gradient Flows of the Entropy, *arXiv:1808.05419*.

19. (with D. Lenz, M. Schmidt) Geometric properties of Dirichlet forms under order isomorphisms, *arXiv:1801.08326*.

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## 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)
- 2017–2018 associate member of the DFG research training group ‘Quantum and Gravitational Fields’
- 2016 Oberwolfach Leibniz Graduate Student (OWLG)
- 2013–2015 Scholarship of German Academic Scholarship Foundation (Studienstiftung des deutschen Volkes)

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## 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

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## Teaching

### Courses as Instructor

- 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)

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## Collaborators

- Cédric Arhancet (Lycée général Lapérouse Albi, work in progress)
- Lorenzo Dello Schiavo (ISTA)
- Matthias Erbar (Bielefeld)
- Bobo Hua (Fudan University)
- Matthias Keller (Potsdam)
- Daniel Lenz (Jena)
- Jan Maas (ISTA)
- Shreya Mehta (Imperial College London, work in progress)
- Florentin Münch (Max Planck Institute Leipzig, work in progress)
- Christian Richter (Jena)
- Cambyse Rouzé (TU Munich)
- Marcel Schmidt (Jena)
- Michael Schwarz (Potsdam)
- Matthijs Vernooij (TU Delft)
- Timon Weinmann (St. Petersburg)
- Haonan Zhang (ISTA)

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## Community Service

### Reviewing

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

### 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

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## Talks

- 11/2022 Research Seminar 'Analysis, Dynamical Systems and Mathematical Physics' at FSU Jena: *Generators of GNS-symmetric Quantum Markov Semigroups*
- 10/2022 Workshop 'OTET 10 – Noncommutative Ergodic Theory' at University Kiel: *Generators of GNS-Symmetric Quantum Markov Semigroups*
- 09/2022 Workshop 'Optimal Transport on Quantum Structures', Rényi Institute Budapest: *The Differential Structure of Generators of GNS-Symmetric Quantum Markov Semigroups*
- 08/2022 One-Day Workshop 'Noncommutative Integration', TU Delft: *A Christensen-Evans theorem for GNS-symmetric quantum Markov semigroups*
- 07/2022 Conference 'New Challenges in Operator Semigroups', University of Oxford: *Generators of GNS-symmetric quantum Markov semigroups*
- 12/2021 Seminar 'Functional Analysis, Operator Theory and Dynamical Systems', online: *Curvature-dimension conditions for quantum Markov semigroups*
- 02/2021 Workshop 'Entropy Inequalities, Quantum Information and Quantum Physics', Institute for Pure and Applied Mathematics (IPAM) at University of California, Los Angeles: *From Entropic Curvature Bounds to Logarithmic Sobolev Inequalities*
- 01/2021 PDE Afternoon of SFB 'Taming Complexity in Partial Differential Systems', University Vienna: *Entropic gradient flow structure of quantum Markov semigroups*
- 01/2021 Workshop 'Geometry, Dynamics and Spectrum of Operators on Discrete Spaces', Mathematisches Forschungsinstitut Oberwolfach (MFO): *Logarithmic Sobolev inequalities for quantum Markov semigroups – an optimal transport approach*
- 11/2020 MathPhys Analysis Seminar, IST Austria: *Gradient estimates for quantum Markov semigroups and return to equilibrium*
- 05/2020 Conference 'Canadian Operator Symposium', Fields Institute Toronto: *Quantum Markov Semigroups as Gradient Flows of the Entropy*
- 06/2019 Conference 'Geometric aspects of harmonic analysis and spectral theory', Technion, Haifa: *Sobolev-Type Inequalities and Eigenvalue Growth on Graphs with Finite Measure*
- 06/2019 Seminar of Research Training Group 'Energy, Entropy, and Dissipative Dynamics', RWTH Aachen: *Entropic gradient flow structure of quantum Markov semigroups*
- 07/2018 Jena-Leipzig-Seminar, FSU Jena: *The Geometry of Geodesics in Discrete Optimal Transport*
- 03/2018 Closing workshop Research Training Group 'Quantum and Gravitational Fields', FSU Jena: *The Heat Flow as Gradient Flow of the Entropy*
- 08/2017 Summer school 'Analysis and Theoretical Numerical Analysis', Siegmundsburg: *Laplacians and isometries of metric measure spaces*

- 03/2017 Workshop ‘Interface between Commutative and Non-Commutative Stochastic Analysis’, Hokkaido University Sapporo: *A transport metric for Dirichlet forms and gradient flows of the entropy*
- 03/2017 Workshop ‘Dirichlet Forms and Their Geometry’, Tohoku University Sendai: *Geometric properties of Dirichlet forms under order isomorphisms*
- 03/2017 Winter school ‘From Particle Dynamics to Gradient Flows’, TU Kaiserslautern: *Dirichlet forms and gradient flows of the entropy*
- 01/2017 Seminar ‘Discrete spectral geometry’, University of Potsdam: *A transport metric for non-local Dirichlet forms and gradient flows of the entropy*
- 12/2016 Workshop ‘Operator Theory and Indefinite Inner Product Spaces’, TU Vienna: *Uniqueness of form extensions and domination of semigroups*
- 11/2016 Workshop ‘Heat kernels, stochastic processes and functional inequalities’, Mathematisches Forschungsinstitut Oberwolfach (MFO): *Geometric properties of Dirichlet forms under order isomorphisms*
- 09/2016 Summer school ‘Spectral Theory, Differential Equations and Probability’, University of Mainz: *Does Diffusion Determine the Geometry?*
- 07/2016 Summer school ‘Analysis and Theoretical Numerical Analysis’, Siegmundsburg: *Uniqueness of form extensions via domination of semigroups*
- 07/2016 Students’ conference of the Deutschen Mathematikervereinigung (DMV), TU Berlin: *Uniqueness of form extensions on  $L^2$  spaces*
- 01/2016 Workshop ‘Spectral Geometry’, University of Potsdam: *Domination of semigroups and uniqueness of form extensions*
- 01/2015 Workshop ‘New Directions in Mathematical Physics and beyond’, FSU Jena: *Does diffusion determine the graph structure?*