Dorian Rudolph

{mail@}dorianrudolph.com

Research Interests

- **Quantum complexity theory**
- Quantum algorithms, cryptography, boson sampling
- Theoretical computer science

Education

- *(Expected late 2025)* PhD in Computer Science, Paderborn University, Germany 2021–2025
  Thesis: The quantum satisfiability problem and more *(working title)*
  Supervisor: Prof. Dr. Sevag Gharibian
- Master in Computer Science, Paderborn University, GPA 1.0[1] 2018–2020
  Thesis: On the Power of P with Access to a QMA Oracle
  Supervisor: Prof. Dr. Sevag Gharibian
- Bachelor in Computer Science, Paderborn University, GPA 1.0 2015–2018
  Thesis: Decontaminating Planar Regions With Finite Automaton Robots and Tiles
  Supervisor: Prof. Dr. Christian Scheideler

Employment

- Research assistant for Prof. Dr. Sevag Gharibian, Quantum Computation, Department of Computer Science & Institute for Photonic Quantum Systems (PhoQS), Paderborn University 2021–now
- Freelance software developer (Embedded Linux, C++) 2022
- Student research assistant for Prof. Dr. Christian Scheideler, Theory of Distributed Systems, Paderborn University 2016–2020
- Software developer at Ferber-Software GmbH, Lippstadt (C#, TypeScript, SQL) 2013–2017

Preprints

1. D. Rudolph. Towards a universal gateset for QMA_1. arXiv:2411.02681, 2024.
   - Poster at QIP 2025.

Publications and Talks

2. J. Kamminga, D. Rudolph. On the Complexity of Pure-State Consistency of Local Density Matrices. arXiv:2411.03096, 2024.
   - Talk at QIP 2025 (both authors are students).
3. M. Aldi, S. Gharibian, D. Rudolph. An unholy trinity: TFNP, polynomial systems, and the quantum satisfiability problem. arXiv:2412.19623, 2024.
   - Talk at TQC[2] 2024 (Theory of Quantum Computation, Communication and Cryptography).
   - Poster at QIP[2] 2024 (Quantum Information Processing).

[1] German grades go from 1.0 (best) to 5.0 (fail).
[2] QIP is the flagship conference in quantum information. TQC is a leading conference in quantum computation.

4. D. Rudolph, S. Gharibian, D. Nagaj. Quantum 2-SAT on low dimensional systems is QMA_1-complete: Direct embeddings and black-box simulation. arXiv:2401.02368, 2024.
   - Proceedings of the 16th Innovations in Theoretical Computer Science Conference (ITCS 2025), DOI:10.4230/LIPIcs.ITCS.2025.85.
   - Talk at TQC 2024.
   - Poster at QIP 2024.
5. A. Agarwal, S. Gharibian, V. Koppula, D. Rudolph. Quantum Polynomial Hierarchies: Karp-Lipton, error reduction, and lower bounds. arXiv:2401.01633, 2024.
   - Proceedings of the 49th International Symposium on Mathematical Foundations of Computer Science (MFCS 2024), DOI:10.4230/LIPIcs.MFCS.2024.7.
   - Poster at QIP 2024.
6. S. Gharibian, D. Rudolph. Quantum space, ground space traversal, and how to embed multi-prover interactive proofs into unentanglement. arXiv:2206.05243, 2022.
   - Proceedings of the 14th Innovations in Theoretical Computer Science Conference (ITCS 2023), DOI:10.4230/LIPIcs.ITCS.2023.53, 2023.
   - Talk at QIP 2022.
7. S. Gharibian, D. Rudolph. On polynomially many queries to NP or QMA oracles. arXiv:2111.02296, 2021.
   - Proceedings of the 13th Innovations in Theoretical Computer Science Conference (ITCS 2022), DOI:10.4230/LIPIcs.ITCS.2022.75.
   - Talk at TQC 2022.
   - Poster at QIP 2022.

Non-quantum computing work:

8. K. Hinnenthal, D. Rudolph, C. Scheideler. Shape Formation in a Three-dimensional Model for Hybrid Programmable Matter.
   - Talk at 36th European Workshop on Computational Geometry, [ext. abstract], 2020.
9. D. Rudolph. Approximating the Sweepwidth of Polygons with Holes.
   - Talk at 35th European Workshop on Computational Geometry (EuroCG) [ext. abstract], 2019.
10. R. Gmyr, K. Hinnenthal, I. Kostitsyna, F. Kuhn, D. Rudolph, C. Scheideler. Shape Recognition by a Finite Automaton Robot.
    - Proceedings of the 43rd International Symposium on Mathematical Foundations of Computer Science (MFCS 2018), DOI:10.4230/LIPIcs.MFCS.2018.52.
11. R. Gmyr, K. Hinnenthal, I. Kostitsyna, F. Kuhn, D. Rudolph, C. Scheideler, T. Strothmann. Forming tile shapes with simple robots.
    - Natural Computing **19**, DOI:10.1007/s11047-019-09774-2, 2020.
    - Proceedings of DNA Computing and Molecular Programming (DNA 2018), DOI:10.1007/978-3-030-00030-1_8.

Invited Workshops and Talks

1. Talk at LIP6 (Sorbonne University) in 2024, hosted by A. Grilo.
   On the Complexity of Pure-State Consistency of Local Density Matrices.
2. Talk at IRIF (Université Paris Cité) in 2024, hosted by S. Apers.
   Towards a universal gateset for QMA_1.
3. Talk at the Slovak Academy of Sciences in 2024, hosted by D. Nagaj.
   Quantum 2-SAT on low dimensional systems is QMA_1-complete: Direct embeddings and black-box simulation.
4. Dagstuhl Seminar 21261: Quantum Complexity: Theory and Application, 2021.

5. Bertinoro Workshop on Distributed Geometric Algorithms, DiG 2019.
6. Dagstuhl Seminar 18331: Algorithmic Foundations of Programmable Matter, 2018.

Teaching

- **Teaching assistant:** Computability and Complexity 2025
- **Supervisor:** Master's student project group. 2024–2025
  Topic: Vector Graphics on Modern Hardware
- **Supervisor:** Bachelor thesis of Simon-Luca Kremer. 2024
  Quantum k-SAT Related Hypergraph Problems

Service

- **Chair:** 2nd NRW Quantum Theoretical CS Workshop (web). Invited speakers: 2024
  S. Apers, J. Eisert, O. Gühne, R. König, T. Stollenwerk, M. Stroeks, M. Walter, R. de Wolf
- **Local organizer:** 50th International Colloquium on Automata, Languages, 2023
  and Programming (ICALP 2023)
- **Reviewer:**
  - CCC 2023 (Computational Complexity Conference)
  - CIMP 2024, 2025 (Communications in Mathematical Physics)
  - ICALP 2025 (International Colloquium on Automata, Languages and Programming)
  - IEEE Transactions on Information Theory 2023
  - ITCS 2025 (Innovations in Theoretical Computer Science)
  - JACM 2025 (Journal of the ACM)
  - MFCS 2022 (Mathematical Foundations of Computer Science)
  - QCTIP 2025 (Quantum Computing Theory in Practice)
  - QIP 2023, 2024, 2025 (Quantum Information Processing)
  - SICOMP 2025 (SIAM Journal on Computing)
  - TQC 2023 (Theory of Quantum Computation, Communication and Cryptography)

Distinctions and Awards

- Master thesis: Award for outstanding thesis 2022
  (effectively best STEM thesis award at Paderborn University)
- Bachelor thesis: Award for outstanding academic achievements 2019
- PRISMA Program 2019–2020
  (Elite research funding program for talented Master students)
- Heinz-Nixdorf Program (Support for talented Bachelor students) 2017–2018
- Founding member of the CTF team and nonprofit "/upb/hack e.V.". 2018–now
  We teach students about hacking and participate in "capture the flag" information security competitions. 3rd place in "Cyber Security Rumble Germany" and "Midnight Sun CTF".
- Scholarship: German Academic Scholarship Foundation (18.000€ total) 2015–2020
  "Germany's largest, oldest and most prestigious scholarship foundation."
- Winner of the 33rd Bundeswettbewerb Informatik 2015
  (5 winners across Germany, federal computer science competition for high school students)