

# Peter Mühlbacher

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: [peter-muehlbacher](#) | : [petermuehlbacher](#)

## SUMMARY

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Ph.D. candidate trained in mathematics and physics, with strong interdisciplinary skills developed from extensive collaboration with international research groups and ability to work independently or as part of a team.

Special expertise in the following areas:

- Statistics
- Data Analysis
- Quantum Mechanics
- Monte Carlo Simulations
- Probabilistic Forecasting
- High-dimensional Probability Theory

## EDUCATION

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**Warwick University**, Coventry, UK

Ph.D, Mathematics

2018 – 2022

Concentrations: Probability Theory, Quantum Spin Systems, Monte Carlo Simulations

**Cambridge University**, Cambridge, UK

MASt., Mathematics

2017

Concentrations: Probability Theory, Mathematical Physics

**Vienna University**, Vienna, Austria

BSc., Mathematics

2016

## EXPERIENCE

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**Dissertation Research**

2018–2022

Dissertation: "Probabilistic Methods for Quantum Spin Systems"

- Designed algorithms to efficiently sample from high-dimensional distributions
- Taught in part master's/Ph.D courses on Quantum Mechanics and Statistical Mechanics
- Collaborated & co-authored papers with groups based in Europe, America, and Asia
- Presented original research at international conferences with 50–500 attendees

**Unicredit Bank Austria (risk management)**

2018

- Analysed & advised on the implementation of an EU regulation
- Communicated amendments to this implementation to the Austrian Financial Market Authority

**Institute for Science & Technology (Vienna)**

2016–2018

- Awarded the OeAD research scholarship (€2200) and a paid internship (acceptance rate: 3%)
- Published a paper on Random Matrix Theory

**Institute for Quantum Optics and Quantum Information (Vienna)**

2015–2016

- Assisted with study design, to be carried out by the European Space Agency

**Paramedic**

2013–2014

- Full-time from July to March, on a voluntary basis afterwards

**Webdesign and Databases**

2008–2012

- Developed several companies' websites
- Deployed HTML, CSS, JavaScript, PHP, and SQL

**Forecasting on Metaculus**

2021–present

- [Public track record](#) of my probabilistic predictions on Covid, economics, etc.
- Investigated a potential "arbitrage" opportunity by analysing historical data

## PUBLICATIONS AND PRESENTATIONS

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P. Mühlbacher, "*Split-and-Merge in Stationary Random Stirring on General Graphs*", pending publication.

- Found a new way of sampling from high-dimensional distributions and used it to improve state-of-the-art results

P. Mühlbacher, "*A New Loop Algorithm with Theoretical Implications*", pending publication.

- Introduced a novel Monte Carlo algorithm for quantum spin systems and used it to prove new results
- Subject to further investigation with a group in Germany
- Presented in Mannheim (online)

J. Björnberg, P. Mühlbacher, B. Nachtergaele, D. Ueltschi, "*Dimerization in Quantum Spin Chains with  $O(n)$  Symmetry*", Communications in Mathematical Physics volume 387, pages 1151–1189 (2021)

- Employed a delicate cluster expansion to prove surprising results about quantum spins
- "This is a fabulous paper. Congratulations" ~ Elliott Lieb (Princeton)
- Presented at [ICMP](#), in Italy (and at Harvard by B. Nachtergaele)

P. Mühlbacher, "*Critical parameters for loop and Bernoulli percolation*", ALEA volume 18, pages 289–308 (2021)

- Proved an open conjecture about comparisons between different probabilistic models
- Presented in Venice, Milton Keynes, Warsaw, Bristol

L. Erdős, P. Mühlbacher, "*Bounds on the Norm of Wigner-type Random Matrices*", Random Matrices: Theory and Applications, volume 08 (2019)

- Used graphical representations & results from Computer Science to prove bounds on Random Matrices
- Presented in Montréal, Vienna, Warwick, Dortmund

P. Mühlbacher, "*Gaussian Free Field and Liouville Quantum Gravity*", 2017

- Cambridge master's thesis, 87% ( $\alpha$ -grade standard)

P. Mühlbacher, "*Diffusion Maps*", 2015

- Bachelor thesis on dimensionality reduction and numerical methods for stochastic partial differential equations
- Awarded highest possible mark

P. Mühlbacher, "*High Dimensional Landscapes and Random Matrices*", 2016

- Bachelor thesis on large deviations of spectral statistics and their applications to spin glasses & neural networks
- Awarded highest possible mark

P. Mühlbacher, "*Protein Docking*", 2015

- Report with a focus on numerics and an efficient implementation

P. Mühlbacher, "*Elliptic Curves and their Applications in Public Key Cryptography*", 2012 (in German)

- Won the Dr. Hans-Riegel award, worth €600

## EXTRACURRICULARS

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### Languages

- English (fluent), German (native), French (basics), Russian (basics), Chinese (basics)
- Taught two German language courses to ~15 students for a year

### Programming

- Python (NumPy, SymPy, Jupyter notebooks, dynamically fetching data from websites)
- Java (Processing)
- LaTeX
- Web (HTML, CSS, JavaScript, PHP, some SQL)
- [Git](#)

### Other Activities

- Former gymnast
- Following developments in Machine Learning (set up a group of ~30 students in Cambridge to share materials)
- Peer-reviewed for Discrete Applied Mathematics