

# Matthew Kwan | CV

**Citizenship**      Australian  
**Date of Birth**     8 January 1992  
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**Address**           Am Campus 1, A-3400 Klosterneuburg, Austria

## Employment & Education

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### **Assistant Professor**

Institute for Science and Technology Austria (ISTA)  
2021 – present

### **Szegő Assistant Professor**

Stanford University  
2018 – 2021

### **Doctor of Science in Mathematics**

With ETH medal  
ETH Zürich  
2014 – 2018.  
Adviser: Benny Sudakov

### **Bachelor of Commerce and Bachelor of Science (Advanced Mathematics)**

With first-class honours and the university medal in pure mathematics  
University of New South Wales  
2010 – 2014.  
Honours adviser: Catherine Greenhill

## Awards & Scholarships

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### **Recent prizes**

- Prize of the Austrian Mathematical Society (ÖMG Förderungspreis), 2024
- SIAM Dénes Kőnig Prize, 2020
- ETH Medal, 2019
- NWMA (New World Mathematics Awards) Silver Medal, 2019

### **Major grants and scholarships**

- European Research Council (ERC) Starting Grant “RANDSTRUCT”, 2023 – 2028  
(project number 101076777; EUR €1 343 890)
- USA National Science Foundation (NSF) standard grant, 2020 – 2023  
(award number 1953990; US \$179 217)
- Swiss National Science Foundation (SNSF) Early Postdoc.Mobility Fellowship, 2018 – 2020  
(project number 178493; US \$75 150)

## Teaching

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### **Extremal Graph Theory (ISTA)**

Autumn 2023: instructor

### **Introduction to the Probabilistic Method (ISTA)**

Autumn 2022: instructor

### **Introduction to Combinatorics and its Applications (Stanford University)**

Spring 2021: instructor

### **Discrete Probabilistic Methods (Stanford University)**

Spring 2019, 2020, 2021: instructor

### **Graph Theory (Stanford University)**

Autumn 2019: instructor

### **Introduction To Probability (Stanford University)**

Winter 2019, 2021: instructor

### **Graph Theory (ETH Zürich)**

Spring 2018: organiser and exercise class teacher

Spring 2016, 2017: exercise class teacher

Spring 2015: creation of course materials

### **Algebraic methods in combinatorics (ETH Zürich)**

Autumn 2017: creation of course materials

### **Mathematics (for masters students in architecture; ETH Zürich)**

Autumn 2015: organiser and exercise class teacher

## Academic Service

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### **PhD students supervised**

- Yiting Wang (2023 – present)

### **Postdocs mentored**

- Michael Anastos (2022 – present)
- Oliver Cooley (2022 – 2023)
- Benjamin Moore (2023 – present)
- Lyuben Lichev (2024 – present)
- Kalina Petrova (2024 – present)

### **Conference/workshop organisation**

- Co-organiser of the 2025 Random Structures and Algorithms conference in Vienna
- Co-organiser of a 2024 workshop “Probability meets Combinatorics” at ISTA
- Co-organiser of the biannual “Danube meeting” in discrete maths (a cooperation between ISTA, TU Graz, Masaryk University and the University of Passau), 2023–present

## Departmental responsibilities

- Co-organiser for the ISTA Mathematics Colloquium, 2024 – present
- External member of the ISTA faculty recruitment committee for “information and system sciences”, 2023
- Member of the ISTA Women Search Committee, 2022 – 2023
- Member of the ISTA Interdisciplinary Projects Committee, 2022
- Co-organiser for the ISTA Institute Colloquium, 2021
- Co-organiser for the ISTA Combinatorics, Geometry and Topology Seminar, 2021 – present

## Student project/thesis supervision

- Mihir Singhal (MIT) did a research project with me in Summer 2019. He wrote a paper “Erdős–Littlewood–Offord problem with arbitrary probabilities”, published in *Discrete Mathematics*.
- Zachary Chroman and Mihir Singhal (MIT) did a research project with me in Winter 2020. We wrote a paper “Lower bounds for superpatterns and universal sequences”, published in *Journal of Combinatorial Theory, Series A*.
- Parth Sarin (Stanford) did a small project with me in Spring 2020 to satisfy his “writing in the major” requirements. As a result he wrote an expository paper “The Rödl Nibble”.
- Philippe Pongest (Stanford) wrote his honours thesis (on aspects of extremal and random graph theory) under my supervision, over the 2020–2021 academic year.
- Matin Ansari (Sharif), Zach Hunter (Oxford), Viktor Imrisek (Stanford), Iwo Pilecki–Silva (Cambridge), and Arjun Ranganathan (IISER Pune) did internships under my supervision in 2021–2024.
- For the ISTA graduate school, I have supervised many 2-month “rotation projects” giving students a taste of research in combinatorics (Ali Asadi, Illia Babienko, Seyda Köse, Christoph Günther, Filippo Quattrocchi, Florestan Brunck, Yiting Wang, Yijie Diao, Illya Koval, Roodabeh Safavi, Lena Wurzing, Pavel Arkhipov, Farhood Rostamkhani).

## Outreach

- I participated in interviews with the science writers at ISTA and with *Quanta Magazine*, regarding my resolution of Erdős’ conjecture on high-girth Steiner triple systems. This resulted in the publication of two general-audience articles on my research.
- I participated in an interview for the *Geistesblitz* column in the Austrian newspaper *der Standard*, about my general research directions.
- I gave an introductory lecture on the probabilistic method at a 2022 training camp for the Austrian, Czech, Slovak, Polish and Ukrainian teams for the International Mathematics Olympiad.
- I gave an introductory lecture on Ramsey theory at a special summer school for Ukrainian high school students (at ISTA, in 2022).
- I gave a lecture on Ramsey theory for the 2023 *Kharkiv-Vienna International Science School* (for participants of the Ukrainian Science Olympiads).
- I gave a general-audience *Think and Drink* seminar for the ISTA community in 2022.

**Referee/expert opinion for many journals, conferences and grant agencies, including:** Advances in Combinatorics; Advances in Mathematics; Annals of Combinatorics; Annals of Applied Probability; Bulletin of the London Mathematical Society; Combinatorial Theory; Combinatorica; Combinatorics, Probability and Computing; Discrete Analysis; Discrete and Computational Geometry; Discrete Mathematics; Duke Mathematical Journal; Electronic Journal of

Combinatorics; European Journal of Combinatorics; Forum of Mathematics, Sigma; International Mathematics Research Notices; Israel Journal of Mathematics; Journal of Combinatorial Theory, Series A; Journal of Combinatorial Theory, Series B; Journal of Graph Theory; Journal of the London Mathematical Society; Proceedings of the American Mathematical Society; Proceedings of the London Mathematical Society; International Conference on Randomization and Computation (RANDOM); Random Structures and Algorithms; SIAM Journal on Discrete Mathematics; ACM–SIAM Symposium on Discrete Algorithms (SODA); ACM Symposium on Theory of Computing (STOC); Transactions of the American Mathematical Society.

## Personal Skills

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### Languages

English (native)

German (certified as B1 level in 2016 by the Zürich Graduate School in Mathematics)

## Talks

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### Invited conferences/workshops

- Synergies of Combinatorics and theoretical computer science, Bernoulli Center (EPFL). August 2024.
- Minisymposium on Extremal Combinatorics, British Combinatorial Conference. July 2024.
- Discrete Probability Days, Centre de Recerca Matemàtica (CRM Barcelona). October 2023.
- Workshop on random graphs, Technische Universität Dortmund. September 2023.
- European Conference on Combinatorics, Graph Theory and Applications (EUROCOMB 2023) (plenary speaker), Charles University. August 2023.
- Workshop on Random Graphs, Mathematisches Forschungsinstitut Oberwolfach. March 2023.
- Workshop on Combinatorics, Mathematisches Forschungsinstitut Oberwolfach. January 2023.
- Symposium on Discrete Mathematics (for the discrete mathematics group of the German Mathematical Society), Technische Universität Hamburg. September 2022.
- Recent advances in probabilistic and extremal combinatorics, Congressi Stefano Franscini (ETH Zürich). August 2022.
- Third Southwestern German Workshop on Graph Theory (plenary speaker), Heidelberg University. June 2022.
- Colloquia in Combinatorics, London School of Economics. May 2022.
- Workshop on Combinatorics, Probability and Computing, Mathematisches Forschungsinstitut Oberwolfach. April 2022.
- Interfaces of the Theory of Combinatorial Limits, Erdős Center (Rényi Institute). March 2022.
- Dénes König Prize Lecture, SIAM Conference on Discrete Mathematics (DM21). July 2021.
- Special Session on Structural and Extremal Graph Theory, AMS Fall Southeastern Sectional Meeting. October 2020.
- Probabilistic Combinatorics Online 2020 (plenary speaker). September 2020.
- Workshop on Combinatorics, Mathematisches Forschungsinstitut Oberwolfach. January 2020.

- Workshop on Probabilistic and Extremal Combinatorics, Banff International Research Station for Mathematical Innovation and Discovery (BIRS). September 2019.
- BennyFest (celebrating Benny Sudakov's 50th birthday), ETH Zürich. July 2019.
- Workshop on Combinatorics, Probability and Computing, Mathematisches Forschungsinstitut Oberwolfach. April 2019.
- Minisymposium on Analytic and Probabilistic Techniques in Combinatorics, SIAM Conference on Discrete Mathematics (DM18), University of Colorado, Denver. June 2018.

### Departmental seminars/colloquia

- Mathematical Physics and Analysis Seminar, ISTA. June 2024.
- Combinatorics and Discrete Probability Seminar, University of Illinois Chicago. February 2024.
- Combinatorics Seminar, Stanford University. February 2024.
- Browning group (Number Theory) Working Seminar, ISTA. January 2024.
- Spectral Geometry in the Clouds (seminar on spectral theory and geometric analysis). December 2023.
- Inn'formal Probability Seminar, University of Innsbruck. November 2023.
- Informatics and Mathematics Colloquium, University of Passau. July 2023.
- (Not So) Informal Probability Seminar, University of Vienna. April 2023.
- Groningen Probability Seminar, University of Groningen. February 2023.
- MIT–Harvard–MSR Combinatorics Seminar, Massachusetts Institute of Technology. January 2023.
- Combinatorics, Geometry and Topology Seminar, ISTA. June 2022.
- (Not So) Informal Probability Seminar, University of Vienna. May 2022.
- Discrete Mathematics Seminar, Princeton University. April 2022.
- Graz Combinatorics Seminar, Technische Universität Graz. March 2022.
- Combinatorics Seminar, University of Birmingham. February 2022.
- Discrete Seminar, Umeå University. February 2022.
- Graz Combinatorics Seminar, Technische Universität Graz. December 2021.
- Informatics Colloquium, Masaryk University. November 2021.
- Research Seminar in Combinatorics, Tel Aviv University. November 2021.
- Big Seminar, Laboratory of Combinatorial and Geometric Structures, Moscow Institute of Physics and Technology. November 2021.
- Vienna Probability Seminar. November 2021.
- Discrete Mathematics Seminar, Technische Universität Wien. October 2021.
- CMSA (Combinatorial Mathematics Society of Australasia) Seminar. September 2021.
- Copenhagen–Jerusalem Combinatorics Seminar. July 2021.
- Combinatorics and Probability Seminar, Ohio State University. March 2021.
- MIT–Stanford Combinatorics Reading Seminar. March 2021.
- Mathematics Department Colloquium, University of California, Berkeley. February 2021.
- Webinar on Applied Analysis, Max Planck institute for Mathematics in the Sciences. November 2020.
- Graph Theory Seminar, Georgia Institute of Technology. October 2020.
- Graph Theory and Combinatorics Seminar, University of Illinois. September 2020.
- MIT–Stanford Combinatorics Reading Seminar. July 2020.
- Extremal and Probabilistic Combinatorics webinar. July 2020.

- Matroid Union Seminar. June 2020.
- Probability Seminar, Stanford University. November 2019.
- Combinatorics Seminar, Massachusetts Institute of Technology. February 2019.
- Combinatorics Seminar, Emory University. November 2018.
- Mathematics Department Colloquium, Stanford University. November 2018.
- Combinatorics Reading Seminar, Stanford University. October 2018.
- Combinatorics Seminar, Stanford University. October 2018.
- Mittagssseminar (Theory of Combinatorial Algorithms), ETH Zürich. March 2018.
- Horowitz Seminar on Probability, Ergodic Theory and Dynamical Systems, Tel Aviv University. June 2017.
- Graduate Seminar in Probability, ETH Zürich. May 2017.
- Mittagssseminar (Theory of Combinatorial Algorithms), ETH Zürich. November 2016.
- Mittagssseminar (Theory of Combinatorial Algorithms), ETH Zürich. April 2016.
- Pure Mathematics Seminar, University of New South Wales. August 2015.
- Discrete Mathematics Seminar, Monash University. August 2015.
- Algebra and Topology Seminar, Australian National University. August 2015.
- Mittagssseminar (Theory of Combinatorial Algorithms), ETH Zürich. March 2015.

#### Contributed conference talks

- 19th International Conference on Random structures and Algorithms, ETH Zürich. July 2019.
- European Conference on Combinatorics, Graph Theory and Applications (EUROCOMB 2017), TU Wien. August 2017.
- 18th International Conference on Random structures and Algorithms, Gniezno. August 2017.
- SIAM Conference on Discrete Mathematics (DM16), Georgia State University. June 2016.
- European Conference on Combinatorics, Graph Theory and Applications (EUROCOMB 2015), University of Bergen. August 2015.
- 17th International Conference on Random structures and Algorithms, Carnegie Mellon University. July 2015.
- 37th Australasian Conference on Combinatorial Mathematics and Combinatorial Computing, University of Western Australia. December 2013.

## Publications

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48. M Kwan, R Safavi and Y Wang. Counting perfect matchings in Dirac hypergraphs. Submitted.
47. M Anastos, B Auerbach, M A Baig, M Cueto Noval, M Kwan, G Pascual-Perez and K Pietrzak. The cost of maintaining keys in dynamic groups with applications to multicast encryption and group messaging. Submitted.
46. V Jain, M Kwan and M Michelen. Entangled states are typically incomparable. Submitted.
45. M Glasgow, M Kwan, A Sah and M Sawhney. A central limit theorem for the matching number of a sparse random graph. Submitted.
44. M Kwan and L Sauermann. Resolution of the quadratic Littlewood–Offord problem. Submitted.

43. M Anastos, Z Jin, M Kwan, B Sudakov. Extremal, enumerative and probabilistic results on ordered hypergraph matchings. Submitted.
42. M Anastos, O Cooley, M Kang and M Kwan. Partitioning problems via random processes. Submitted.
41. M Glasgow, M Kwan, A Sah and M Sawhney. The exact rank of sparse random graphs. Submitted.
40. M Kwan and Y Wigderson. The inertia bound is far from tight. *Bulletin of the London Mathematical Society*, to appear.
39. M Kwan, A Sah, M Sawhney and M Simkin. High-girth Steiner triple systems. *Annals of Mathematics*, to appear.
38. F Brunck and M Kwan. Books, hallways and social butterflies: a note on sliding block puzzles. *The Mathematical Intelligencer*, to appear.
37. I Koval, M Kwan. Exponentially many graphs are determined by their spectrum. *Quarterly Journal of Mathematics* 75.3 (2024), 869–899.
36. M Kwan, A Sah, M Sawhney and M Simkin. Substructures in Latin squares. *Israel Journal of Mathematics* 256 (2023), 363–416.
35. M Kwan, A Sah, L Sauermann and M Sawhney. Anticoncentration in Ramsey graphs and a proof of the Erdős–McKay conjecture. *Forum of Mathematics, Pi* 11:E21 (2023).
34. A Ferber, M Kwan, A Sah and M Sawhney. Singularity of the  $k$ -core of a random graph. *Duke Mathematical Journal* 172.7 (2023), 1293–1332.
33. J Fox, M Kwan and H Spink. Geometric and o-minimal Littlewood–Offord problems. *Annals of Probability* 51.1 (2023), 101–126.
32. M Kwan, A Sah and M Sawhney. Enumerating matroids and linear spaces. *Comptes Rendus Mathématique* 361 (2023), 565–575.
31. A Ferber, M Kwan, B Narayanan, A Sah and M Sawhney. Friendly bisections of random graphs. *Communications of the American Mathematical Society* 2 (2022), 380–416.
30. A Ferber and M Kwan. Dirac-type theorems in random hypergraphs. *Journal of Combinatorial Theory, Series B* 155 (2022), 318–357.
29. M Kwan, A Sah and M Sawhney. Large deviations in random Latin squares. *Bulletin of the London Mathematical Society* 54.4 (2022), 1420–1438.
28. M Kwan, L Sauermann and Y Zhao. Extension complexity of low-dimensional polytopes. *Transactions of the American Mathematical Society*, 375 (2022), 4209–4250.
27. A Ferber, M Kwan and L Sauermann. List-decodability with large radius for Reed–Solomon codes. *IEEE Transactions on Information Theory* 68.6 (2022), 3823–3828. A conference version appeared at FOCS 2021.
26. M Kwan and L Sauermann. On the permanent of a random symmetric matrix. *Selecta Mathematica* 8.15 (2022).
25. A Ferber, M Kwan and L Sauermann. Singularity of sparse random matrices: simple proofs. *Combinatorics, Probability and Computing* 31.1 (2022), 21–28.
24. J Fox, M Kwan and L Sauermann. Combinatorial anti-concentration inequalities, with applications. *Mathematical Proceedings of the Cambridge Philosophical Society* 171.2 (2021), 227–248.
23. Z Chroman, M Kwan and M Singhal. Lower bounds for superpatterns and universal sequences. *Journal of Combinatorial Theory, Series A* 156:105467 (2021).
22. J Fox, M Kwan and L Sauermann. Anticoncentration for subgraph counts in random graphs. *Annals of Probability* 49.3 (2021), 1515–1553.
21. J Fox, M Kwan and B Sudakov. Acyclic subgraphs of tournaments with high chromatic number. *Bulletin of the London Mathematical Society* 53.2 (2021), 619–630.
20. A Ferber and M Kwan. Almost all Steiner triple systems are almost resolvable. *Forum of Mathematics, Sigma* 8:E39 (2020).

19. M Bucic, M Kwan, A Pokrovskiy and B Sudakov. Halfway to Rota's basis conjecture. *International Mathematics Research Notices* 2020.21 (2020), 8007–8026.
18. X He and M Kwan. Universality of random permutations. *Bulletin of the London Mathematical Society* 52.3 (2020), 515–529.
17. M Bucic, M Kwan, A Pokrovskiy, B Sudakov, T Tran and A Z Wagner. Nearly-linear monotone paths in edge-ordered graphs. *Israel Journal of Mathematics* 238 (2020), 663–685.
16. M Kwan and L Sauermann. An algebraic inverse theorem for the quadratic Littlewood–Offord problem, and an application to Ramsey graphs. *Discrete Analysis* 2020:12 (2020).
15. M Kwan. Almost all Steiner triple systems have perfect matchings. *Proceedings of the London Mathematical Society* 121.6 (2020), 1468–1495.
14. M Kwan, S Letzter, B Sudakov and T Tran. Dense induced bipartite subgraphs in triangle-free graphs. *Combinatorica* 40 (2020), 283–305.
13. M Kwan and B Sudakov. Ramsey graphs induce subgraphs of quadratically many sizes. *International Mathematics Research Notices* 2020.6 (2020), 1621–1638.
12. D Conlon, J Fox, M Kwan and B Sudakov. Hypergraph cuts above the average. *Israel Journal of Mathematics* 233.1 (2019), 67–111.
11. M Kwan and B Sudakov. Proof of a conjecture on induced subgraphs of Ramsey graphs. *Transactions of the American Mathematical Society* 372 (2019), 5571–5594.
10. M Kwan, B Sudakov and T Tran. Anticoncentration for subgraph statistics. *Journal of the London Mathematical Society* 99.3 (2019), 757–777.
9. M Krivelevich, M Kwan, P-S Loh and B Sudakov. The random  $k$ -matching-free process. *Random Structures and Algorithms* 53.4 (2018), 692–716.
8. A Ferber, M Kwan and B Sudakov. Counting Hamilton cycles in sparse random directed graphs. *Random Structures and Algorithms* 53.4 (2018), 592–603.
7. M Kwan, B Sudakov and P Vieira. Non-trivially intersecting multi-part families. *Journal of Combinatorial Theory, Series A* 156 (2018), 44–60.
6. M Kwan and B Sudakov. Intercalates and discrepancy in random Latin squares. *Random Structures and Algorithms* 52.2 (2018), 181–196.
5. A S Bandeira, A Ferber and M Kwan. Resilience for the Littlewood–Offord Problem. *Advances in Mathematics* 319 (2017), 292–312.
4. C Greenhill, M Isaev, M Kwan and B McKay. The average number of spanning trees in sparse graphs with given degrees. *European Journal of Combinatorics* 63 (2017), 6–25.
3. M Krivelevich, M Kwan and B Sudakov. Bounded-degree spanning trees in randomly perturbed graphs. *SIAM Journal on Discrete Mathematics* 31.1 (2017), 155–171.
2. M Krivelevich, M Kwan and B Sudakov. Cycles and matchings in randomly perturbed digraphs and hypergraphs. *Combinatorics, Probability and Computing* 25.6 (2016), 909–927.
1. C Greenhill, M Kwan and D Wind. On the number of spanning trees in random regular graphs. *Electronic Journal of Combinatorics* 21(1):P1.45 (2014).