Antti Knowles

University of Geneva, Section of Mathematics
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Research Interests Probability, analysis, mathematical physics; random matrices, random graphs, statistical mechanics, stochastic processes, high-dimensional statistics, quantum field theory, quantum dynamics.

Employment

2019 – now: Associate professor, *University of Geneva*.

2016 – 2019: Assistant professor, *University of Geneva*.

2014 – 2016: Assistant professor, *ETH Zürich*.

2013 – 2014: Member, *Institute for Advanced Study*.

2012 – 2013: Assistant professor / Courant Instructor, *Courant Institute, New York University*.

2009 – 2012: Postdoctoral fellow, *Harvard University*.

Education

2010: Doctorate in theoretical physics, *ETH Zürich*, supervised by Jürg Fröhlich.

2005: Dipl. Phys. ETH mit Auszeichnung (summa cum laude), *ETH Zürich*.

Distinctions

2022: ERC Consolidator Grant (PI) – EUR 1,947,431.

2021: Research Professor for MSRI semester program.

2016: ERC Starting Grant (PI) – EUR 1,257,442.

2014: Swiss National Science Foundation grant (PI) – CHF 1,099,990.

2012: Annales Henri Poincaré prize.

2012: Harvard University Certificate of Teaching Excellence.

2011: Harvard University Certificate of Teaching Excellence.

2005: ETH Pólya-award.

Publications and preprints

[42] *Localized phase for the Erdős-Rényi graph*, with J. Alt and R. Ducatez. Preprint arXiv:2305.16294, 83 pages, to appear in Comm. Math. Phys.

[41] *The Euclidean ϕ_2^4 theory as a limit of an interacting Bose gas*, with J. Fröhlich, B. Schlein, and V. Sohinger. Preprint arXiv:2201.07632, 62 pages, to appear in J. Eur. Math. Soc.

[40] *The completely delocalized region of the Erdős-Rényi graph*, with J. Alt and R. Ducatez. Elect. Comm. Prob. **27** (2022), 1–9.

[39] *Poisson statistics and localization at the spectral edge of sparse Erdős-Rényi graphs*, with J. Alt and R. Ducatez. Ann. Prob. **51** (2023), 277–358.

[38] *Interacting loop ensembles and Bose gases*, with J. Fröhlich, B. Schlein, and V. Sohinger. Ann. Henri Poincaré **24** (2023), 1439–1503.

[37] *Delocalization transition for critical Erdős-Rényi graphs*, with J. Alt and R. Ducatez. Comm. Math. Phys. **388** (2021), 507-579.

[36] *Fluctuations of extreme eigenvalues of sparse Erdős-Rényi graphs*, with Y. He. Prob. Theor. Rel. Fields. **180** (2021), 985–1056.

[35] *A path-integral analysis of interacting Bose gases and loop gases*, with J. Fröhlich, B. Schlein, and V. Sohinger. J. Stat. Phys. **180** (2020) (special issue in honour of Joel Lebowitz), 810–831.

[34] *The mean-field limit of quantum Bose gases at positive temperature*, with J. Fröhlich, B. Schlein, and V. Sohinger. J. Amer. Math. Soc. **35** (2022), 955–1030.

[33] *Edge rigidity and universality of random regular graphs of intermediate degree*, with R. Bauerschmidt, J. Huang, and H.-T. Yau. Geom. Funct. Anal. **30** (2020), 693–769.

[32] *Extremal eigenvalues of critical Erdős-Rényi graphs*, with J. Alt and R. Ducatez. Ann. Prob. **49** (2021), 1347–1401.

[31] *Mesoscopic eigenvalue density correlations of Wigner matrices*, with Y. He. Prob. Theor. Rel. Fields **177** (2020), 147–216.

[30] *Local law and complete eigenvector delocalization for supercritical Erdős-Rényi graphs*, with Y. He and M. Marcozzi. Ann. Prob. **47** (2019), 3278–3302.

[29] *Largest eigenvalues of sparse inhomogeneous Erdős-Rényi graphs*, with F. Benaych-Georges and C. Bordenave. Ann. Prob. **47** (2019), 1653–1676.

[28] *Spectral radii of sparse random matrices*, with F. Benaych-Georges and C. Bordenave. Ann. Inst. Henri Poincaré **56** (2020), 2141–2161.

[27] *A microscopic derivation of time-dependent correlation functions of the* $1D$ *cubic nonlinear Schrödinger equation*, with J. Fröhlich, B. Schlein, and V. Sohinger. Adv. Math. **353** (2019), 67–115.

[26] *Isotropic self-consistent equations for mean-field random matrices*, with Y. He and R. Rosenthal. Prob. Theor. Rel. Fields. **171** (2017), 203–249.

[25] *Gibbs measures of nonlinear Schrödinger equations as limits of many-body quantum states in dimensions* $d \leqslant 3$, with J. Fröhlich, B. Schlein, and V. Sohinger. Comm. Math. Phys. **356** (2017), 883–980.

[24] *Mesoscopic eigenvalue statistics of Wigner matrices*, with Y. He. Ann. Appl. Prob. **27** (2017), 1510–1550.

[23] *Eigenvalue confinement and spectral gap for random simplicial complexes*, with R. Rosenthal. Rand. Struct. Algor. **51** (2017), 506–537.

[22] *Bulk eigenvalue statistics for random regular graphs*, with R. Bauerschmidt, J. Huang, and H.-T. Yau. Ann. Prob. **45** (2017), 3626–3663.

[21] *Local semicircle law for random regular graphs*, with R. Bauerschmidt and H.-T. Yau. Comm. Pure Appl. Math. **70** (2017), 1898-1960.

[20] *Anisotropic local laws for random matrices*, with J. Yin. Prob. Theor. Rel. Fields **169** (2017), 257–352.

[19] *On the principal components of sample covariance matrices*, with A. Bloemendal, H.-T. Yau, and J. Yin. Prob. Theor. Rel. Fields **164** (2016), 459–552.

[18] *The Altshuler-Shklovskii formulas for random band matrices II: the general case*, with L. Erdős. Ann. H. Poincaré **16** (2015), 709–799.

[17] *The Altshuler-Shklovskii formulas for random band matrices I: the unimodular case*, with L. Erdős. Comm. Math. Phys. **333** (2015), 1365–1416.

[16] *Isotropic local laws for sample covariance and generalized Wigner matrices*, with A. Bloemendal, L. Erdős, H.-T. Yau, and J. Yin. Elect. J. Prob. **19** (2014), no. 33, 54 pages.

[15] *The local semicircle law for a general class of random matrices*, with L. Erdős, H.-T. Yau, and J. Yin. Elect. J. Prob. **18** (2013), no. 59, 58 pages.

[14] *The outliers of a deformed Wigner matrix*, with J. Yin. Ann. Prob. **42** (2014), 1980–2031.

[13] *Delocalization and diffusion profile for random band matrices*, with L. Erdős, H.-T. Yau, and J. Yin. Comm. Math. Phys. **323** (2013), 367–416.

[12] *Averaging fluctuations in resolvents of random band matrices*, with L. Erdős and H.-T. Yau. Ann. H. Poincaré **14** (2013), 1837–1925.

[11] *The isotropic semicircle law and deformation of Wigner matrices*, with J. Yin. Comm. Pure Appl. Math. **66** (2013), 1663–1750.

[10] *Spectral statistics of Erdős-Rényi graphs II: eigenvalue spacing and the extreme eigenvalues*, with L. Erdős, H.-T. Yau, and J. Yin. Comm. Math. Phys. **314** (2012), 587–640.

[9] *Spectral statistics of Erdős-Rényi graphs I: local semicircle law*, with L. Erdős, H.-T. Yau, and J. Yin. Ann. Prob. **41** (2013), 2279–2375.

[8] *Eigenvector distribution of Wigner matrices*, with J. Yin. Prob. Theor. Rel. Fields **155** (2013), 543–582.

[7] *Quantum diffusion and delocalization for band matrices with general distribution*, with L. Erdős. Ann. H. Poincaré **12** (2011), 1227–1319.

[6] *Quantum diffusion and eigenfunction delocalization in a random band matrix model*, with L. Erdős. Comm. Math. Phys. **303** (2011), 509–554.

[5] *Mean-field dynamics: singular potentials and rate of convergence*, with P. Pickl. Comm. Math. Phys. **298** (2010), 101–139.

[4] *A microscopic derivation of the time-dependent Hartree-Fock equation with Coulomb two-body interaction*, with J. Fröhlich. J. Stat. Phys. **145** (2011), 23–50.

[3] *On the mean-field limit of bosons with Coulomb two-body interaction*, with J. Fröhlich and S. Schwarz. Comm. Math. Phys. **288** (2009), 1023–1059.

[2] *Semi-classical dynamics in quantum spin systems*, with J. Fröhlich and E. Lenzmann. Lett. Math. Phys. **82** (2007), no. 2–3, 275–296.

[1] *Atomism and quantization*, with J. Fröhlich and A. Pizzo. J. Phys. A **40** (2007), 3033–3045.

Books

Lectures on the local semicircle law for Wigner matrices, with F. Benaych-Georges, in *Advanced Topics in Random Matrices.* Panoramas et Synthèses **53** (2016), Société Mathématique de France.

Editorial boards

2022 – present: *Annales de l'Institut Fourier.*

2020 – present: *Annals of Applied Probability.*

2018 – present: *Journal of Statistical Physics.*

2018 – present: *L'Enseignement Mathématique.*

2015 – 2020: *Electronic Journal of Probability* and *Electronic Communications in Probability.*

Invited lectures

26.06.2023 – 30.06.2023, Bonn: one-week course in Hausdorff School *Recent Advances in Quantum and Statistical Mechanics*.

27.03.2023 – 31.03.2023, TU Eindhoven: one-week course in Eurandom workshop *Spectra of random graphs and related combinatorial problems*.

12.08.2019 – 16.08.2019, ZiF Bielefeld: one-week course in summer school *Randomness in physics and mathematics*.

25.06.2018 – 29.06.2018, University of Michigan: one-week course at the 2018 Michigan Summer School on Random Matrices.

01.09.2017 – 13.09.2017, Ghiffa: one-week course in Summer School X on Probability and Mathematical Physics.

17.07.2017 – 21.07.2017, University of Zürich: one-week course in summer school *Current Topics in Mathematical Physics*.

12.01.2016, Hausdorff Center Bonn: two-hour lecture in workshop *Probability and asymptotic analysis in strongly coupled systems*.

02.03.2015 – 04.03.2015, Imperial College London: CFM-Imperial Distinguished Lectures.

09.02.2015 – 13.02.2015, Les Diablerets: one-week course in conference *Topics in low dimensional statistical mechanics*.

02.12.2014 – 03.12.2014, Institut Henri Poincaré: two-day minicourse in SMF conference *États de la recherche en matrices aléatoires*.

05.05.2014 – 09.05.2014, University of Helsinki: one-week course at the Centre of Excellence of the Academy of Finland.

27.06.2012 – 28.06.2012, IMA at the University of Minnesota: two-day minicourse in summer school *Advances in random matrix theory*.

Invited conference addresses

22.03.2023, Princeton: conference *Mathematical Challenges in Quantum Physics*.

28.09.2022, Cologne: conference *Universal Structures in Probabilistic Models*.

29.06.2022, Helsinki: conference *Probability and mathematical physics*.

30.05.2022, MF Oberwolfach: workshop *Universality: Random Matrices, Random Geometry and SPDEs*.

28.04.2022, Les Diablerets: conference on localization.

24.09.2021, MSRI: Connections and introductory workshop for program *Universality and Integrability in Random Matrix Theory and Interacting Particle Systems*.

26.05.2020: conference *Online random matrices and their applications 2020*.

19.02.2020, Florence: conference *Random Schrödinger operators and related topics*.

15.01.2020, CIRM Marseille: workshop *Spectra, algorithms and random walks on random networks*.

09.12.2019, MF Oberwolfach: workshop *Random matrices*.

08.10.2019, University of Grenoble, workshop GDR *Analyse Fonctionelle, Harmonique et Probabilités*.

13.09.2019, MF Oberwolfach: workshop *Many-body quantum systems*.

23.08.2019, Venice: conference *Quantissima in the Serenissima*.

07.08.2019, BIRS at Banff: conference *From many body problems to random matrices* in honour of H.T. Yau's 60th birthday.

22.05.2019, Fondation Les Treilles: workshop *Mean-field and other effective models in mathematical physics.*

11.04.2019, Institut Mittag-Leffler: workshop in programme *Spectral Methods in Mathematical Physics.*

18.01.2019, Institut Mittag-Leffler: kick-off conference for programme *Spectral Methods in Mathematical Physics.*

15.12.2018, Brunel University: *XIV Brunel-Bielefeld Workshop on Random Matrix Theory.*

05.12.2018, MF Oberwolfach: workshop *Free probability.*

23.05.2018, Kyoto: workshop *Random matrices and their applications.*

19.04.2018, MF Oberwolfach: workshop *Gibbs measures for nonlinear dispersive equations.*

23.03.2018, Darmstadt: school *Spin Systems: Discrete and Continuous.*

22.08.2017, Venice: conference *Quantissima in the Serenissima.*

02.06.2017, ETH Zürich: workshop *Mathematical Aspects of Disordered Systems.*

30.05.2017, MF Oberwolfach: workshop *Stochastic Analysis.*

03.04.2017, ENS Lyon: conference *ProbabLY ON Random Matrices.*

01.03.2017, CIRM Marseille: workshop *Random Matrices and Determinantal Process.*

15.07.2016, Fields Institute Toronto: World congress in probability and statistics.

28.06.2016, Institut Henri Poincaré: conference *Optimal and random point configurations.*

04.01.2016, CIRM Marseille: workshop *Spectre de graphes aléatoires.*

11.12.2015, Bielefeld: workshop *Random Matrix Theory and Applications.*

20.09.2015, Hamburg: workshop *Recent trends in stochastic analysis and related topics.*

11.06.2015, MF Oberwolfach: workshop *Free probability.*

20.02.2015, Strasbourg: meeting *Frontiers in analysis and probability.*

09.01.2015, University of Hong Kong: conference *Random matrices and their applications.*

19.09.2014, Stockholm-Uppsala analysis and probability day.

29.07.2014, SPA Buenos Aires.

06.06.2014, MF Oberwolfach: workshop *Stochastic Processes.*

09.04.2014, Zürich: Imperial-ETHZ workshop on mathematical finance.

20.03.2014, Warwick: EPSRC Symposium on Statistical Mechanics.

16.01.2014, Baltimore: AMS National Meeting.

31.10.2013, Banff: Workshop on Disordered Quantum Many-Body Systems.

12.09.2013, ICTP Trieste: workshop *Random matrices and growth models.*

28.05.2013, ETH Zürich: workshop *Analytical aspects of mathematical physics.*

30.04.2013, Max-Planck-Institut Leipzig: conference *Emerging trends in probability theory.*

19.09.2012, Newton Institute: workshop *The mathematics and physics of disordered systems.*

29.05.2012, Hausdorff Center Bonn: workshop *Random matrices.*

04.08.2011, Venice: conference *Quantissima in the Serenissima.*

01.06.2011, MF Oberwolfach: workshop *Stochastic Processes*.

18.05.2011, Harvard University: FRG workshop.

17.12.2010, AMS-SOMACHI meeting in Pucón.

11.08.2010, Les Houches: summer school *Quantum mechanics from small to large scales*.

23.05.2010, University of Rochester: FRG workshop.

20.04.2010, Harvard University: Friends of the Harvard Mathematics Department.

17.03.2010, University of Arizona, Tucson: school *Analysis and applications*.

27.08.2008, Les Houches: summer school *Long-range interacting systems*.

25.07.2008, ESI Vienna: conference *Analysis and quantum*.

Seminars and colloquia

02.11.2022: ETH Zürich: probability seminar.

16.06.2022: One world probability seminar (online).

11.04.2022, Bangalore probability seminar (online).

15.09.2021, UC Berkeley probability seminar (online).

31.08.2021, One world IAMP mathematical physics seminar (online).

09.04.2021, Séminaire matrices et graphes aléatoires (online).

12.03.2021, University of Chicago: probability seminar (online).

27.11.2020, University of Oxford: random matrix seminar (online).

18.05.2020, University of Geneva: mathematical physics seminar (online).

06.05.2020, Harvard University: probability seminar (online).

04.12.2019, Queen Mary University London: probability seminar.

27.09.2019, University of Geneva: statistics seminar.

03.05.2019, EPF Lausanne: analysis seminar.

25.01.2019, University of Frankfurt: *Rhein-Main Kolloquium Stochastik*.

14.12.2018, University of Basel: Basel-Zürich analysis seminar.

28.05.2018, Institut Henri Poincaré: seminar *Problèmes spectraux en physique mathématique*.

21.02.2018, University of Warwick: probability seminar.

07.02.2018, IMPA: probability seminar.

07.12.2017, Ludwig-Maximilians-Universität München: colloquium.

01.12.2017, University of Bielefeld: colloquium in mathematical physics.

28.11.2017, University of Grenoble: probability seminar.

27.11.2017, University of Grenoble: mathematical physics seminar.

15.05.2017, KTH Stockholm: probability seminar.

25.04.2017, University of Fribourg: colloquium.

22.03.2017, University of Zürich: probability seminar.

07.03.2017, University of Cambridge: probability and statistics seminar.

03.02.2017, Institut Henri Poincaré: seminar *GdT Matrices et graphes aléatoires*.

15.12.2016, University of Geneva: colloquium.

15.11.2016, University of Geneva: geometry seminar.

07.11.2016, University of Geneva: mathematical physics seminar.

15.06.2016, University of Cologne: colloquium.

03.03.2016, ENS Lyon: probability seminar.

08.02.2016, Massachusetts Institute of Technology: probability seminar.

02.02.2016, Harvard University: probability seminar.

04.11.2015, University of Basel: analysis seminar.

22.10.2015, SISSA Trieste: mathematical physics seminar.

25.06.2015, ESI Vienna: mathematical physics seminar.

23.03.2015, EPF Lausanne: mathematics seminar.

27.02.2015, CFM Paris: research seminar.

28.01.2015, UC Berkeley: Neyman Seminar.

27.11.2014, Ludwig-Maximilians-Universität München: mathematical physics seminar.

17.11.2014, University of Geneva: mathematical physics seminar.

07.10.2014, University of Fribourg: colloquium.

24.04.2014, University of Indiana: probability seminar.

21.04.2014, Caltech: mathematical physics seminar.

18.04.2014, Brown University: PDE seminar.

13.03.2014, ETH Zürich: mathematical physics seminar.

12.02.2014, University of Geneva: mathematical physics seminar.

10.12.2013, University of Pennsylvania: probability and combinatorics seminar.

09.12.2013, Institute for Advanced Study: members seminar.

08.04.2013, University of Michigan: analysis and probability seminar.

05.03.2013, Princeton University: mathematical physics seminar.

12.01.2013, University of Cambridge: probability and statistics seminar.

12.10.2012, New York University: probability seminar.

05.10.2012, Columbia University: probability seminar.

04.10.2012, Rutgers University: mathematical physics seminar.

14.03.2012, University of Zürich: probability seminar.

10.02.2012, Northwestern University: analysis seminar.

25.01.2012, Brandeis University: colloquium.

17.01.2012, University of Cambridge: probability and statistics seminar.

13.01.2012, University of Warwick: colloquium.

12.01.2012, University of Warwick: statistical mechanics seminar.

06.12.2011, Massachusetts Institute of Technology: analysis seminar.

05.12.2011, University of Massachusetts Amherst: colloquim.

02.12.2011, University of Minnesota: probability seminar.

06.10.2011, University of Chicago: probability seminar.

17.08.2011, University of Helsinki: analysis seminar.

08.07.2011, Ludwig-Maximilians-Universität München: analysis seminar.

26.07.2010, Taida Institute for Mathematical Sciences, Taiwan: probability seminar.

18.06.2010, Ludwig-Maximilians-Universität München: analysis seminar.

26.05.2010, University of California, Davis: probability seminar.

22.02.2010, Harvard University: basic notions seminar.

17.11.2009, Massachusetts Institute of Technology: analysis seminar.

13.01.2009, Universität Heidelberg: mathematical physics seminar.

21.10.2008, Ludwig-Maximilians-Universität München: analysis seminar.

13.10.2008, University of Helsinki: analysis seminar.

Teaching

Probability and statistics (Geneva, autumn 2023 – spring 2024); Brownian motion and stochastic calculus (Geneva, autumn 2023); Probability and statistics (Geneva, autumn 2022 – spring 2023); Large deviations (Geneva, spring 2022); Probability and statistics (Geneva, spring 2022); Probability and statistics (Geneva, autumn 2020 – spring 2021); Random matrices and universality (Geneva, autumn 2019); Enumerative combinatorics (Geneva, autumn 2019); Brownian motion and stochastic calculus (Geneva, spring 2017); Analysis I (Geneva, autumn 2016, autumn 2017, autumn 2018); Theoretical physics for mathematicians (ETH, spring 2016); Random graphs (ETH, autumn 2015); Applied stochastic processes (ETH, spring 2015); Concentration of measure (ETH, autumn 2014); Random matrix theory (ETH, spring 2014); Analysis 2 (Courant, spring 2013); Calculus 2 (Courant, fall 2012); Harmonic analysis (Harvard, spring 2012); Graduate probability (Harvard, fall 2011); Complex analysis (Harvard, spring 2011); Calculus (Harvard, fall 2010); Dynamical systems (Harvard, spring 2010); Dynamics of large quantum systems (Harvard, fall 2009).

2014–2016: co-organizer of student seminar on probability at ETH.

Students

Postdoctoral advisor of Alessio Ranallo (Geneva, 2023–), Philippe Moreillon (Geneva, 2023–), Trishen Gunaratnam (with Hugo Duminil-Copin, Geneva, 2020–), Raphaël Butez (Geneva, 2020–2021), Johannes Alt (Geneva, 2018–2022), Raphaël Ducatez (Geneva, 2018–2021), Justine Louis (Geneva, 2018–2021), Matteo Marcozzi (Geneva, 2017–2018), Vedran Sohinger (ETH Zürich, 2014–2016).

PhD advisor of Steffen Polzer (2022–), Renaud Rivier (2018–2023), Yukun He (2015–2018).

Service and organization

Examiner for PhD theses of François Pagano (Geneva, 2023), Andrew Rout (University of Warwick, 2023), Simon Coste (University Paris Diderot, 2019), Joël Bun (University of Paris Sud, 2016), Yuriy Nemish (University of Toulouse, 2016), Torben Krüger (University of Munich, 2015), Peng Mei (University of Helsinki, 2014).

2024: Elected member of the executive committee of the International Association of Mathematical Physics (IAMP).

2023: Member of the evaluation committe of the Laboratoire de Probabilités, Statistique et Modélisation (LPSM).

2022: Co-organizer of conference *Random matrices and random landscapes*, in honour of Yan Fyodorov's 60th birthday, in Monte Verità, Ascona.

2022: Co-organizer of conference *Quantissima in the Serenissima IV* in Venice.

2021: Session organizer at the Young Researcher Symposium, ICMP 2021, Geneva.

2019: Co-organizer of conference *Random graphs and random matrices* at CIRM, Luminy.

2018: Session organizer for the 40th Conference on Stochastic Processes and their Applications.

2016 – present: Co-organizer of Geneva mathematical physics seminar.

2014 – 2016: Zürich graduate school admissions committee.

2014 – 2016: Co-organizer of Zürich seminar on stochastic processes.

2012: Harvard University graduate student admissions committee.

2011: Co-organizer of FRG workshop at Harvard.

Reviewer for Grants of *National Science Foundation (USA)*, *NSA/AMS (USA)*, *Royal Society (UK)*, *Swiss National Science Foundation*, *European Research Council*, *Research Grants Council of Hong Kong*, *Israel Science Foundation*.