

Hao Shen

Mathematics Department, University of Wisconsin-Madison
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ACADEMIC POSITIONS

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|-----------------|--|
| 2018.8 - Now | Assistant Professor, University of Wisconsin - Madison
<small>* Offered in 2017 and deferred the start date to 2018</small> |
| 2015.8 - 2018.7 | Ritt Assistant Professor and Minerva Fellow, Columbia University
<small>* Offered in 2014 and deferred the start date to 2015</small> |
| 2014.8 - 2015.7 | Research Associate, University of Warwick, Mentor: Martin Hairer |
| 2013.8 - 2014.7 | Research Associate, Princeton University, Mentor: Weinan E |

EDUCATION

- May 2013 PhD. Princeton University. Advisor: Weinan E
- June 2008 MSc. Peking University. Advisor: Gang Tian
- June 2006 BSc. Peking University. Undergraduate thesis advisor: Huijun Fan

RESEARCH INTERESTS

Stochastic PDE, probability, stochastic analysis, mathematical physics, quantum field theory, statistical mechanics, interacting particle systems.

PUBLICATIONS AND PREPRINTS

1. H. Shen, R. Zhu and X. Zhu, Large N limit of the $O(N)$ linear sigma model in 3D, *arXiv:2102.02628*, submitted.
2. A. Chandra, I. Chevyrev, M. Hairer and H. Shen, Langevin dynamic for the 2D Yang-Mills measure, *arXiv:2006.04987*, submitted.
3. H. Shen, S. Smith, R. Zhu and X. Zhu, Large N limit of the linear sigma model via stochastic quantization, *Ann. Probab.* (accepted).
4. H. Shen, J. Song, R. Sun and L. Xu, Scaling limit of a directed polymer among a Poisson field of independent walks, *J. Funct. Anal.* (accepted).
5. Julien Dubédat and H. Shen, Stochastic Ricci flow on compact surfaces, *Int. Math. Res. Not.* (accepted).
6. I. Corwin and H. Shen, Some recent progress in singular stochastic partial differential equations, *Bulletin of the American Mathematical Society* 57.3 (2020): 409-454.
7. A. Chandra, D. Erhard and H. Shen, Local solution to the multi-layer KPZ equation, *J. Stat. Phys.* **175** (2019), no. 6, 1080-1106.
8. A. Chandra, M. Hairer and H. Shen, The dynamical sine-Gordon model in the full subcritical regime, *arXiv:1808.02594*.
9. H. Shen and L.-C. Tsai, Stochastic Telegraph equation limit for the stochastic six vertex model, *Proc. Amer. Math. Soc.* 147 (2019), 2685-2705
10. I. Corwin, P. Ghosal, H. Shen and L.-C. Tsai, Stochastic PDE limit of the six vertex model, *Comm. Math. Phys.* (2020): 1-94.
11. H. Shen, Stochastic quantization of an Abelian gauge theory, *Comm. Math. Phys.* (accepted)
12. I. Corwin and H. Shen, Open ASEP in the weakly asymmetric regime, *Comm. Pure Appl. Math.* 71, no. 10 (2018): 2065-2128.
13. H. Shen and H. Weber, Glauber dynamics of 2D Kac-Blume-Capel model and their stochastic PDE limits, *J. Funct. Anal.* Vol 275, Issue 6, (2018), 1321-1367

14. A. Chandra and H. Shen, Moment bounds for SPDEs with non-Gaussian fields and application to the Wong-Zakai problem, *Electron. J. Probab. Vol 22 (2017)*, paper no. 68.
15. I. Corwin, H. Shen and L-C. Tsai, ASEP (q,j) converges to the KPZ equation, *Ann. Inst. Henri Poincaré (B) Probab. Stat. (2018)*, **54**, No. 2, 995-1012.
16. H. Shen and W. Xu, Weak universality of dynamical Φ_3^4 : non-Gaussian noise, *Stoch PDE: Anal Comp (2017)*.
17. M. Hairer and H. Shen, A central limit theorem for the KPZ equation, *Ann. Probab.* **45** (2017), no. 6B, 4167-4221.
18. M. Hairer and H. Shen, The dynamical sine-Gordon model, *Comm. Math. Phys.* **341** (2016), no. 3, 933-989
19. I. Corwin, T. Seppäläinen and H. Shen, The strict-weak lattice polymer, *J. Stat. Phys.* **160** (2015), no. 4, 1027-1053
20. W. E and H. Shen, Exact renormalization group analysis of turbulent transport by the shear flow, *J. Stat. Phys.* **153** (2013), no. 4, 553-571
21. W. E and H. Shen, Mean field limit of a dynamical model of polymer systems, *Sci. China Math.* **56** (2013), no. 12, 2591-2598
22. H. Shen, A renormalization group method by harmonic extensions and the classical dipole gas, *Ann. Henri Poincaré* **17** (2016), no. 4, 861-911
23. W. E, A. Jentzen and H. Shen, Renormalized powers of Ornstein-Uhlenbeck processes and well-posedness of stochastic Ginzburg-Landau equations, *Nonlinear Anal.* **142** (2016), 152-193

PAPERS IN PROGRESS

1. A. Chandra, I. Chevyrev, M. Hairer and H. Shen, Stochastic Yang-Mills process in 3D

LECTURE NOTES, WORKSHOP REPORTS

1. H. Shen, Lecture notes for Math 833 “Topics in the Theory of Probability” (on stochastic PDE) at University of Wisconsin-Madison
2. H. Shen, Lecture notes for course “Topics in Stochastic PDE” at Columbia University
3. H. Shen, *SPDEs with three types of multiplicative noises*, Oberwolfach workshop report “Rough Paths, Regularity Structures and Related Topics” (2016), no. 24, 65-66.

THESES

- *PhD Thesis: Renormalization Theory in Statistical Physics and Stochastic Analysis*
Committee: Michael Aizenman & Weinan E (Supervisor) & Thomas Spencer
Description: This thesis consists of: (1) a rigorous renormalization group method based on harmonic extensions; (2) well-posedness of a class of stochastic Ginzburg-Landau equations; (3) rigorous renormalization group study of turbulent transport by the shear flow.
- *Master Thesis: Anti-self-dual metrics on four-manifolds*
Supervisor: Gang Tian
Description: This thesis studies the anti-self-dual metrics on four-manifolds, the linear theory, their relation with complex structures and local structure of moduli spaces. Some examples are also given.

GRANTS, AWARDS, HONORS

- NSF CAREER, DMS-2044415 (2021-2026);
- NSF DMS-1954091 (2020-2023);
- UW-Madison Fall competition award (2019; withdrawn upon receiving NSF)
- “Editors’ pick from the Annals of Probability”, 2018 IMS Annual Meeting at Vilnius;
- NSF DMS-1804339 (Conference Grant, Co-PI, 2018-2019);
- NSF DMS-1712684 (2017-2020, changed to DMS-1909525 when PI moved to Madison);
- Axioms Travel Awards (2017);
- AMS Simons Travel Grant (2016 - 2018);
- Columbia University Minerva Foundation Fellowship (2015 - 2019);
- Princeton University Centennial Fellowship (2008 - 2012).

TEACHING EXPERIENCE (INCLUDING UPCOMING COURSES)

Spring	2021	Introduction to the Theory of Probability (Math 431), Wisconsin - Madison
Fall	2020	Stochastic Analysis (Math 735), Wisconsin - Madison
Spring	2020	Topics on SPDE (Math 833), Univ. of Wisconsin - Madison
Spring	2020	An Introduction to Brownian Motion and Stochastic Calculus (Math 635), Univ. of Wisconsin - Madison
Spring	2019	Introduction to the Theory of Probability (Math 431), Univ. of Wisconsin - Madison
Fall	2018	Stochastic Analysis (Math 735), Univ. of Wisconsin - Madison
Spring	2018	Calculus IV (Two sections), Columbia University
Fall	2017	Calculus IV, Columbia University
Spring	2017	Topics in Stochastic PDE, Columbia University
Fall	2016	Calculus IV (Two sections), Columbia University
Summer	2016	Ordinary Differential Equations (temporary instructor), Columbia University
Spring	2016	Calculus IV, Columbia University
Fall	2015	Calculus I (Two sections), Columbia University
Fall	2010	Topics in Applied Mathematics, Princeton University (I gave about eight lectures.)
Spring	2007	Linear Algebra (teaching assistant), Peking University

LECTURES AND MINI-COURSES

- 7/25 - 8/05/2016, Peking University, Two-week summer course on stochastic PDEs and regularity structures
- Spring 2017, Columbia University, One semester topics course on Stochastic PDE
- 7/16 - 7/20/2018, Chinese Academy of Sciences, Supplementary lectures for Martin Hairer’s course on the theory of regularity structures.
- 7/30 - 8/03/2018, Chinese Academy of Sciences, Mini-lectures on Stochastic PDE in “The International Program on Regularity Structures and Stochastic Systems”
- Spring 2020, University of Wisconsin-Madison, One semester topics course on SPDE
- 8/2020, Chinese Academy of Sciences - Beijing Institute of Technology joint SPDE summer school, One-week summer course “*Quantum field theory and stochastic PDE*”
- 11/5-6/2020, Two informal online mini-lectures on “*Stochastic Quantization*” for “Quantization Days” organized by E.Peltola and Y.Wang
- 12/2020, Shandong University, Online lectures on “*Quantum field theory and stochastic PDE*”

CONFERENCE AND WORKSHOP TALKS

1. 13th AIMS Conference on Dynamical Systems, Differential Equations and Applications, Session “Stochastic modeling in biological, physical and social sciences: theory and applications”, Title: *SPDE limit of polymers in dynamical environments*. Rome, Italy. Summer/2022
2. 13th AIMS Conference on Dynamical Systems, Differential Equations and Applications, Session “Stochastic partial differential equations”, Title: *Some recent results in stochastic quantization*. Rome, Italy. Summer/2022
3. Random Matrix EurAsia, Singapore, Title: TBA 4/18-5/13/2022
4. BIRS workshop on Random Growth Models, Banff, Canada, (postponed) 9/12–9/17, 2021
5. 10th International Conference on Stochastic Analysis and its Applications (ICSAA), Kyoto, Title: TBA 9/6–9/10/2021
6. Bath Mathematical Symposium on “PDE and Randomness”, Title: TBA 9/1–9/10/2021
7. 20th International Congress on Mathematical Physics (ICPM), Geneva, session “Nonequilibrium Statistical Mechanics”, 8/2-8/7/2021
8. 10th World Congress in Probability and Statistics, Seoul (changed to online), Session “Stochastic Partial Differential Equations” organized by L.Mytnik 7/19-7/23/2021
9. Webinar on Analysis and PDEs (4), organized by Yu Deng, Title: *Stochastic quantization of Yang-Mills* 4/30/2021
10. AIM Workshop “Criticality and stochasticity in quasilinear fluid systems”, San Jose (changed to online), Title: *Stochastic quantization of Yang-Mills* 4/5-4/9/2021
11. Online talk for Integrable Probability FRG meeting Title: *SPDE limit of a directed polymer in Poisson random walks* 4/3/2020
12. Symposium on Probability and Statistics, Chinese Academy of Sciences, Title: *Stochastic quantization of gauge theories* 12/15/2019
13. Workshop “SPDE day – recent progress on quasilinear equations”, Hausdorff Institute, Bonn, Title: *Stochastic Ricci flow on surfaces*. 10/18/2019
14. AMS Sectional Meeting, Session “Stochastic Partial Differential Equations and Related Fields”, Madison, organized by Igor Cialenco, Yu Gu, and Hyun-Jung Kim, Title: *Stochastic quantization of gauge theories*. 9/15/2019
15. IMS-China 2019, Dalian, Invited session “KPZ equations and related models”, Title: *Local solution to the multilayer KPZ equation*; 7/9/2019
16. IMS-China 2019, Dalian, Invited session “Rough path and SPDE” organized by Weijun Xu, Title: *Stochastic quantization of gauge theories*; 7/8/2019
17. Conference “Paths between Probability, PDEs, and Physics”, Imperial College London, organized by Chandra, Hairer, Xu, Title: *Stochastic Ricci flow on compact surfaces*, 7/5/2019
18. Conference “Probability and quantum field theory: discrete models, CFT, SLE and constructive aspects”, Porquerolles (France), June 10th - 21st, organized by Christophe Garban, Rémi Rhodes, Vincent Vargas. Title: *Stochastic Ricci Flow on Compact Surfaces* 6/13/2019
19. AMS Sectional Meeting, Special session “Advances in Mathematical Fluid Mechanics”, University of Hawaii, Title: *Stochastic Burgers equation from six vertex model*; 3/23/2019
20. Workshop “Scaling limits & SPDEs: recent developments and future directions”, Isaac Newton Institute, Cambridge, Title: *SPDE limits of six vertex model*; 12/13/2018
21. AMS Sectional Meeting “Special Session on Probability, Combinatorics, and Statistical Mechanics”, University of Delaware, Title: *Stochastic quantization of gauge theories*; 9/29/2018
22. Workshop on Statistical Physics and Probability, Beijing International Center for Mathematical Research, Title: *Scaling limit results in SPDE*; 7/22/2018

23. Workshop in International Program on Regularity Structures and Stochastic Systems, Chinese Academy of Sciences, Beijing, Title: *Liouville QFT and Stochastic Ricci Flow*; 7/13/2018
24. 2018 IMS Annual Meeting / 12th International Vilnius Conference on Probability Theory and Mathematical Statistics, Lithuania, invited session “Editors’ pick from the Annals of Probability”, Title: *A central limit theorem for the KPZ equation*; 7/5/2018
25. Integrable Probability FRG Conference at MIT, Boston, Title: *Open ASEP and KPZ equation*; 5/18/2018
26. Recent developments in Constructive Field Theory Workshop, New York, organized by J.Dubedat, F.Viklund, Title: *Stochastic quantization of gauge theories*; 3/14/2018
27. UBC Summer School in Probability, Vancouver, Title: *Lattice gauge theory and stochastic PDE*; 6/13/2017
28. Warwick EPSRC Symposium “Stochastic PDEs: Analysis and Computation”, UK, organized by I.Gyongy, M.Hairer, A.Stuart, Title: *Lattice gauge theory and stochastic PDE*; 3/29/2017
29. 9th World Congress on Probability and Statistics, Toronto, Invited session talk in session “SPDEs and the work of Martin Hairer” organized by I.Corwin, Title: *Stochastic quantization equations and the theory of regularity structures*; 7/13/2016
30. Random Structures in High Dimensions, Oaxaca, Mexico, organized by David Brydges and Frank den Hollander, Title: *A stochastic PDE with $U(1)$ gauge symmetry*; 6/28/2016
31. Workshop on Stochastic Partial Differential Equations, Simons Center for Geometry and Physics, Stony Brook, organized by Martin Hairer, Title: *Some convergence results of discrete dynamics*; 5/20/2016
32. Oberwolfach workshop: rough paths, regularity structures and related topics, Germany, organized by Thomas Cass, Peter Friz and Massimiliano Gubinelli, Title: *SPDEs with three types of multiplicative noises*; 5/5/2016
33. Columbia-Princeton Probability Day, New York, Title: *Regularity structure theory and its applications*; 4/8/2016
34. “Paths to, from and in renormalization: At the confluence of rough paths, algebra, analysis and geometry”, Potsdam (Germany), Title: *Renormalization for stochastic PDEs with non-Gaussian noises*; 2/10/2016
35. Current Topics in Mathematical Physics and Probability, Sanya (China), organized by Paul Bourgade, Horng-Tzer Yau and Jun Yin, Title: *Stochastic PDEs as scaling limits of some microscopic models*; 12/28/2015
36. Pittsburgh workshop on Stochastic PDEs, organized by Dehua Wang, Title: *Regularity structure theory and its applications*; 12/4/2015
37. International Congress on Industrial and Applied Mathematics (ICIAM), Beijing, mini-symposium organized by A.Jentzen, Title: *Renormalization and Stochastic PDEs*, 8/11/2015
38. 38th Conference on Stochastic Processes and their Applications (SPA), Oxford, UK, Title: *A central limit theorem for the KPZ equation*, (Contributed talk); 7/14/2015
39. Peking University Youth Probability Forum, Beijing, Title: *Singular stochastic PDEs and the theory of regularity structures* 7/7/2015
40. Random Polymers and Algebraic Combinatorics, Oxford, UK, Clay Mathematics Institute workshop organized by Ivan Corwin and Nikos Zygouras, Title: *The Strict-Weak Lattice Polymer*; 5/25/2015
41. MASDOC summer school “Topics in renormalisation group and regularity structures”, University of Warwick, organized by S.Adams, Title: *Dynamical sine-Gordon equation*; 5/11/2015
42. 3rd Annual ERC Berlin-Oxford Young Researchers Meeting on Applied Stochastic Analysis, Weierstrass Institute, Berlin, Title: *Dynamical sine-Gordon model*; 1/27/2015

43. 13th Northeast Probability Seminar, Columbia University,
Title: *Strict-Weak Polymers and KPZ Universality* 11/21/2014
44. Special Seminar on KPZ, Berkeley, Title: *Strict-weak polymers and KPZ universality*, organized by
Ivan Corwin and Fraydoun Rezakhanlou 7/10/2014
45. Workshop on Harmonic Analysis and the Renormalization Group, U. of Virginia, Title: *Renormalization group by harmonic extensions*, organized by A. Abdesselam; 4/21/2014
46. Workshop on Stochastic Analysis and Related Topics, Chinese Academy of Sciences, *Renormalization and well-posedness of stochastic PDEs*, organized by Xiangdong Li; 8/6/2013

SEMINAR TALKS

1. Random Geometry and Statistical Physics seminar (4/20/2021)
2. University of Kansas Probability Seminar (4/14/2021)
3. Stochastic Webinar, organized by Beijing Institute of Technology / Chinese Academy of Sciences
SPDE limit of a directed polymer in Poisson random walks (3/9/2021)
4. UCSD Probability Seminar, *Stochastic quantization and Yang-Mills* (2/25/2021)
5. Probability and the City Seminar, organized jointly by Columbia and Courant,
Stochastic quantization, large N , and mean field limit (2/12/2021)
6. Berkeley Probability Seminar, *Stochastic quantization and Yang-Mills* (10/14/2020)
7. Beijing Institute of Technology, *Stochastic quantization of gauge theories* (12/23/2019)
8. University of Bonn Oberseminar Stochastik, *Stochastic quantization of gauge theories* (11/21/2019)
9. Warwick Probability Seminar, *Stochastic Ricci flow on surfaces* (10/16/2019)
10. Princeton Probability Seminar, *Stochastic quantization of Yang-Mills via regularity structures* (4/17/2019)
11. Rochester Probability, Ergodic Theory, Mathematical Physics Seminar, *Stochastic quantization of Yang-Mills via regularity structures* (3/29/2019)
12. Rutgers Mathematical Physics Seminar,
Stochastic quantization of Yang-Mills via regularity structures (3/14/2019)
13. UCLA Probability Seminar, *Stochastic quantization of Yang-Mills via regularity structures* (11/01/2018)
14. Columbia Probability Seminar, *Stochastic quantization of Yang-Mills below four dimensions* (10/05/2018)
15. Wisconsin-Madison Probability Seminar, *Stochastic quantization of Yang-Mills* (9/20/2018)
16. Carnegie Mellon SPDE working group, *Some new results on stochastic heat equations* (4/17/2018)
17. Carnegie Mellon University, Center for Nonlinear Analysis Seminar, *Singular stochastic PDEs and renormalization* (4/17/2018)
18. Cornell Probability Seminar, *Stochastic quantization of gauge theories* (4/10/2018)
19. Duke Probability Seminar, *Stochastic quantization of gauge theories* (3/1/2018)
20. U. of Connecticut Discrete Math and Statistical Mechanics Seminar, *Lattice Gauge Theory and Stochastic PDE* (2/22/2018)
21. Imperial College London Probability Seminar, *Six vertex model and KPZ equation* (11/21/2017)
22. Penn and Temple Probability Seminar, *Some new scaling limit results on ASEP and Glauber dynamics of spin models* (12/6/2016)
23. Wisconsin-Madison Probability Seminar, *On scaling limits of Open ASEP and Glauber dynamics of ferromagnetic models* (12/1/2016)
24. University of Toronto Probability Seminar, *Asymmetric simple exclusion processes with open boundaries and their KPZ equation limits* (10/21/2016)

25. Rutgers Seminar on Mathematical Finance, Probability and PDEs, *Stochastic PDE with $U(1)$ gauge symmetry* (10/4/2016)
26. Chinese Academy of Sciences, *Stochastic PDEs and regularity structures* (8/5/2016)
27. U. of Chicago Probability Seminar, *Regularity structure theory and its applications* (4/15/2016)
28. Brown Dynamical System Seminar, *Regularity structure theory and its applications* (3/14/2016)
29. Harvard University Random Matrix and Probability Seminar, *The sine-Gordon stochastic PDE and regularity structures* (3/11/2016)
30. City University of New York Probability Seminar, *Regularity structure theory and its applications* (3/1/2016)
31. Institute for Advanced Study Analysis Seminar, *Stochastic quantization equations* (2/23/2016)
32. Duke University Probability seminar, *Stochastic PDEs and regularity structures* (10/29/2015)
33. U. of Macau Probability Seminar, *Stochastic PDEs and regularity structures* (8/20/2015)
34. Oxford Stochastic Analysis Seminar, *A central limit theorem for the KPZ equation* (6/15/2015)
35. Max Planck Institute at Leipzig, Analysis Seminar, *Theory of regularity structures and dynamical sine-Gordon model* (1/12/2015)
36. Cambridge Probability Seminar, *Solving the dynamical sine-Gordon equation* (10/21/2014)
37. Loughborough Probability Seminar, *The dynamical sine-Gordon equation* (10/16/2014)
38. Warwick Statistical Mechanics Seminar, *The dynamical sine-Gordon equation* (10/9/2014)
39. University of Virginia Mathematical Physics Seminar, *Renormalization group by conditional expectations and dipole gas revisited* (12/4/2013)
40. Princeton University Ergodic Theory and Statistical Mechanics Seminar, *Renormalization group and stochastic PDEs* (11/21/2013)
41. Chinese Academy of Sciences, *Rigorous Renormalization Group and Applications* (9/2011)

ORGANIZER

- 8/2020, Chinese Academy of Sciences - Beijing Institute of Technology joint SPDE summer school, (Co-organizer)
- 10/21 – 10/25, 2019, Workshop “Singular SPDEs and Related Topics”, Hausdorff Institute for Mathematics in Bonn (Co-organizer)
- 9/23 – 9/27, 2019, Summer School “New Frontiers in Singular SPDEs and Scaling Limits”, Hausdorff Institute for Mathematics in Bonn (Co-organizer)
- 9/14 – 9/15, 2019, Fall Central Sectional Meeting, Special Session on “Large Scale Properties of Interacting Stochastic Systems”, University of Wisconsin-Madison, Madison, (Co-organizing with Timo Seppalainen and Benedek Valko)
- 7/6 – 7/10, 2019, Invited session on “KPZ equations and related models”, IMS-China 2019, Dalian
- 5/1 – 5/3, 2018, Meeting on “Transport and localization in random media: theory and applications” at Columbia University, partially supported by NSF DMS-1804339 (Co-PI) (Co-organizing with Ivan Corwin, Alexis Drouot and Michael Weinstein)
- 2/5/2016, Semi-annual Columbia-Courant joint probability seminar, with theme on Stochastic PDEs, at Columbia University
- 2015–2018, Columbia University Probability Seminar, (co-organizer)

JOURNAL REFEREE

• Annals of Probability; • Annals of Applied Probability; • Annales Henri Lebesgue; • Annales Henri Poincaré; • Archive for Rational Mechanics and Analysis; • Brazilian Journal of Probability and Statistics; • Communications in Mathematical Physics; • Communications in Mathematical Sciences; • Electronic Journal of Probability; • Forum of Mathematics, Pi; • International Mathematics Research Notices; • Journal of Evolution Equations; • Journal of Functional Analysis; • Journal of Mathematical Analysis and Applications; • Journal of Statistical Physics; • Probability Theory and Related Fields; • Science China Mathematics; • Stochastics and Partial Differential Equations: Analysis and Computations. • Transactions of the American Mathematical Society.

COMMITTEE SERVICE

Member of University of Wisconsin - Madison Graduate Advising Committee, Visiting International Student Program Committee, and Conference/special lectures Committee

REFERENCES

David Brydges (db5d@math.ubc.ca), Ivan Corwin (ivan.corwin@gmail.com),
Weinan E (weinan@math.princeton.edu), Martin Hairer (m.hairer@imperial.ac.uk).