Shu-Heng Shao

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ACADEMIC POSITIONS

C. N. Yang Institute for Theoretical Physics, Stony Brook University — Stony Brook, NY
Assistant Professor — 2021 - present

Institute for Advanced Study — Princeton, NJ
Long-term Member, School of Natural Sciences — 2016 - 2021

EDUCATION

Harvard University — Cambridge, MA
Ph.D. in Theoretical Physics — 2016
Dissertation: *Supersymmetric Particles in Four Dimensions*
Advisor: *Xi Yin*

National Taiwan University[1] — Taipei, Taiwan
B.S. in Physics — 2010

COLLOQUIA AND PLENARY TALKS

EuroStrings 2023, review talk: *Non-Invertible Symmetry*	Apr 2023
APS April Meeting, invited speaker, *Non-Invertible Symmetry*	Apr 2023
CU Boulder Colloquium, *Generalized Global Symmetries*	Oct 2022
Yale University Colloquium, *Generalized Global Symmetries*	Sep 2022
CERN Theory Colloquium, *Generalized Global Symmetries*	Mar 2022
Snowmass Theory Frontier Conference, KITP, *Generalized Global Symmetries*	Feb 2022
Strings 2021, review talk: *Symmetries and Their Generalizations in Topological Phases of Matter*	Jul 2021
String Math 2020, *Continuum Quantum Field Theory for Fractons*	Jul 2020
Physics Colloquium, Brandeis University	Feb 2020
Physics Colloquium, University of Washington	Jan 2020
Strings 2018, *Beyond Symmetry: Topological Lines in 2D*	Jul 2018

[1] One-year (2010-2011) mandatory civilian service for the Taiwanese government.

SCIENTIFIC ACTIVITIES

Co-organizer, KITP workshop: *Generalized Symmetries in QFT* 2025
Co-organizer, Aspen Summer Workshop: *Traversing the Particle Physics Peaks: Phenomenology to Formal* Aug 2023
Co-organizer, TASI 2023: *Aspects of Symmetry* Jun 2023

TEACHING

Schools

Lecturer, School on Categorical Symmetries in QFT, SwissMAP Research Station
lectures title: *Non-Invertible Symmetry* Sep 2023
Lecturer, TASI 2023, lectures title: *What's Done Cannot Be Undone: Non-Invertible Symmetry* Jun 2023
Lecturer, Summer School for the Simons Collaboration on the Non-Perturbative Bootstrap Jul 2021

Stony Brook University

String Theory II Spring 2023
String Theory I Fall 2022, Fall 2023
Modern Physics Spring 2022

Harvard University

TF for *Physics 287c: Conformal Field Theory* Fall 2015

ADVISING AND MENTORING

Graduate Students
Yichul Choi (co-advisee with Zohar Komargodski)
Yaman Sanghavi

GRANTS AND AWARDS

Frontiers of Science Award 2023
Simons Collaboration on Ultra-Quantum Matter 2023-
National Science Foundation Award 2022-2025
New World Mathematics Award, Yau Mathematical Sciences Center 2017
Derek Bok Award for Teaching Excellence, Harvard University 2016
Gertrude and Maurice Goldhaber Prize, Harvard University 2014
An Wang Fellowship, Harvard University 2013
Kao Fellowship, Harvard University 2013
An-Tai Chen Research Scholarship, National Taiwan University 2010

JOURNALS REVIEWER

Communications in Mathematical Physics, JHEP, SciPost, Phys. Rev. Lett., Phys. Rev. D., Phys. Rev. B.

OUTREACH

Quanta Magazine article featuring some of my papers: A New Kind of Symmetry Shakes Up Physics

SEMINARS AND WORKSHOPS

Mathematical Picture Language Seminar, Harvard	Aug 2023
KIAS	Jul 2023
McGill University	May 2023
Stanford University	May 2023
Ultra-Quantum Matter Simons Collaboration meeting at CU Boulder	May 2023
Perimeter Institute	Feb 2023
Ultra-Quantum Matter Simons Collaboration Annual Meeting at the Flatiron Institute	Jan 2023
National Taiwan University	Dec 2022
Princeton	Dec 2022
NYU	Nov 2022
Rutgers University	Nov 2022
University of Pennsylvania	Nov 2022
University of Cape Town	Nov 2022
Brandeis University	Nov 2022
Cornell University	Oct 2022
SCGP workshop: Generalized Global Symmetries, Quantum Field Theory, and Geometry	Sep 2022
Instituto Balseiro	Sep 2022
Panel Speaker, Workshop for the Simons Collaboration on Ultra-Quantum Matter, UT Austin	Aug 2022
Workshop Talk at the Snowmass Seattle Community Summer Study Workshop	Jul 2022
UCSD	Jul 2022
Workshop for the Simons Collaboration on Global Categorical Symmetries, Perimeter Institute	Jun 2022
QFT and Geometry Seminar Series	Jun 2022
CAQCD, University of Minnesota	May 2022
Workshop for the Simons Collaboration on Ultra-Quantum Matter, Harvard University	Apr 2022
PCTS Workshop on Boundaries and Defects in CFT and Holography	Mar 2022
Ecole Polytechnique	Dec 2021
UCLA	Nov 2021
Utrecht University	Nov 2021
Kick-off Meeting for the Simons Collaboration on Global Categorical Symmetries, SCGP	Oct 2021
Harvard University	Sep 2021
NHETC, Rutgers University	Sep 2021
DAMTP, Cambridge University	Jun 2021
SISSA	Jun 2021

SCGP Workshop for New directions in topological phases	May 2021
University of Chicago	May 2021
Group Meeting, Institute for Advanced Study	Apr 2021
NL Zoom Seminar	Apr 2021
University of Pennsylvania	Apr 2021
INT Workshop for Topological Phases of Matter, University of Washington	Mar 2021
Caltech	Jan 2021
Workshop for the Simons Collaboration on Ultra-Quantum Matter	Oct 2020
SLAC	Sep 2020
CMSA, Harvard University	May 2020
UC Davis	Apr 2020
YITP, Stony Brook University	Mar 2020
Yale University	Dec 2019
Perimeter Institute	Nov 2019
Rutgers University	Oct 2019
Brandeis University	Sep 2019
CMSA, Harvard University	Sep 2019
CTP, MIT	Sep 2019
Workshop for the Simons Collaboration on Ultra-Quantum Matter, Harvard University	Sep 2019
Workshop for the Simons Collaboration on the Non-perturbative Bootstrap, Perimeter Institute	Jul 2019
Polica Workshop	Jun 2019
Johns Hopkins University	May 2019
CUNY	May 2019
Harvard University	May 2019
Workshop on F-theory, Florida State University	Apr 2019
ICTP	Apr 2019
Caltech	Mar 2019
SCGP	Feb 2019
NHETC, Rutgers University	Oct 2018
Columbia University	Sep 2018
Workshop for the Simons Collaboration on the Non-perturbative Bootstrap, Caltech	Jul 2018
Taiwan String Workshop, National Taiwan University	Jun 2018
CMSA, Harvard University	Apr 2018
Group Meeting, Institute for Advanced Study	Mar 2018
Texas A&M	Mar 2018
UC Davis	Nov 2017
Autumn Symposium on String Theory, KIAS	Sep 2017
Harvard University	Mar 2017
Brown University	Mar 2017
Caltech	Jan 2017
AMS Meeting	Nov 2016
Math Seminar, MIT	Oct 2016
Group Meeting, Institute for Advanced Study	Sep 2016
Perimeter Institute	Jan 2016
Tata Institute of Fundamental Research	Dec 2015
University of Amsterdam	Nov 2015
SLAC	Apr 2015
IPMU	Dec 2014
National Taiwan University	Dec 2014
CMSA, Harvard University	Oct 2014

PUBLICATIONS

The authors are ordered alphabetically.

All my papers can be found on INSPIRE and Google Scholar.

[1] S.-H. Shao, *What's Done Cannot Be Undone: TASI Lectures on Non-Invertible Symmetry*, arXiv:2308.00747.

[2] N. Seiberg and S.-H. Shao, *Majorana chain and Ising model – (non-invertible) translations, anomalies, and emanant symmetries*, arXiv:2307.02534.

[3] Y. Choi, B. C. Rayhaun, Y. Sanghavi, and S.-H. Shao, *Comments on Boundaries, Anomalies, and Non-Invertible Symmetries*, arXiv:2305.09713.

[4] Y.-H. Lin and S.-H. Shao, *Bootstrapping noninvertible symmetries*, *Phys. Rev. D* **107** (2023), no. 12 125025, [arXiv:2302.13900].

[5] Y. Choi, H. T. Lam, and S.-H. Shao, *Non-invertible Gauss Law and Axions*, arXiv:2212.04499.

[6] P. Gorantla, H. T. Lam, N. Seiberg, and S.-H. Shao, *Gapped lineon and fracton models on graphs*, *Phys. Rev. B* **107** (2023), no. 12 125121, [arXiv:2210.03727].

[7] M. Baumgart et al., *Snowmass Theory Frontier: Effective Field Theory*, in *2022 Snowmass Summer Study*, 10, 2022. arXiv:2210.03199.

[8] P. Gorantla, H. T. Lam, N. Seiberg, and S.-H. Shao, *(2+1)-dimensional compact Lifshitz theory, tensor gauge theory, and fractons*, *Phys. Rev. B* **108** (2023), no. 7 075106, [arXiv:2209.10030].

[9] Y. Choi, H. T. Lam, and S.-H. Shao, *Noninvertible Time-Reversal Symmetry*, *Phys. Rev. Lett.* **130** (2023), no. 13 131602, [arXiv:2208.04331].

[10] P. Gorantla, H. T. Lam, and S.-H. Shao, *Fractons on graphs and complexity*, *Phys. Rev. B* **106** (2022), no. 19 195139, [arXiv:2207.08585].

[11] C. Cordova, T. T. Dumitrescu, K. Intriligator, and S.-H. Shao, *Snowmass White Paper: Generalized Symmetries in Quantum Field Theory and Beyond*, in *2022 Snowmass Summer Study*, 5, 2022. arXiv:2205.09545.

[12] Y. Choi, H. T. Lam, and S.-H. Shao, *Noninvertible Global Symmetries in the Standard Model*, *Phys. Rev. Lett.* **129** (2022), no. 16 161601 (Editors' Suggestion), [arXiv:2205.05086].

[13] Y. Choi, C. Cordova, P.-S. Hsin, H. T. Lam, and S.-H. Shao, *Non-invertible Condensation, Duality, and Triality Defects in 3+1 Dimensions*, arXiv:2204.09025.

[14] K. Roumpedakis, S. Seifnashri, and S.-H. Shao, *Higher Gauging and Non-invertible Condensation Defects*, arXiv:2204.02407.

[15] T. Brauner, S. A. Hartnoll, P. Kovtun, H. Liu, M. Mezei, A. Nicolis, R. Penco, S.-H. Shao, and D. T. Son, *Snowmass White Paper: Effective Field Theories for Condensed Matter Systems*, in *2022 Snowmass Summer Study*, 3, 2022. arXiv:2203.10110.

[16] P. Gorantla, H. T. Lam, N. Seiberg, and S.-H. Shao, *Global dipole symmetry, compact Lifshitz theory, tensor gauge theory, and fractons*, *Phys. Rev. B* **106** (2022), no. 4 045112, [arXiv:2201.10589].

[17] Y. Choi, C. Cordova, P.-S. Hsin, H. T. Lam, and S.-H. Shao, *Noninvertible duality defects in 3+1 dimensions*, *Phys. Rev. D* **105** (2022), no. 12 125016 (Editors' Suggestion), [arXiv:2111.01139].

[18] F. J. Burnell, T. Devakul, P. Gorantla, H. T. Lam, and S.-H. Shao, *Anomaly inflow for subsystem symmetries*, *Phys. Rev. B* **106** (2022), no. 8 085113, [arXiv:2110.09529].

[19] P. Gorantla, H. T. Lam, N. Seiberg, and S.-H. Shao, *Low-energy limit of some exotic lattice theories and UV/IR mixing*, *Phys. Rev. B* **104** (2021), no. 23 235116, [arXiv:2108.00020].

[20] J. Kaidi, Z. Komargodski, K. Ohmori, S. Seifnashri, and S.-H. Shao, *Higher central charges and topological boundaries in 2+1-dimensional TQFTs*, *SciPost Phys.* **13** (2022) 067, [arXiv:2107.13091].

[21] P. Gorantla, H. T. Lam, N. Seiberg, and S.-H. Shao, *A modified Villain formulation of fractons and other exotic theories*, *J. Math. Phys.* **62** (2021), no. 10 102301, [arXiv:2103.01257].

[22] Y.-H. Lin and S.-H. Shao, $\mathbb{Z}_N$ *symmetries, anomalies, and the modular bootstrap*, *Phys. Rev. D* **103** (2021), no. 12 125001, [arXiv:2101.08343].

[23] T. Rudelius, N. Seiberg, and S.-H. Shao, *Fractons with Twisted Boundary Conditions and Their Symmetries*, *Phys. Rev. B* **103** (2021), no. 19 195113, [arXiv:2012.11592].

[24] P. Gorantla, H. T. Lam, N. Seiberg, and S.-H. Shao, *fcc lattice, checkerboards, fractons, and quantum field theory*, *Phys. Rev. B* **103** (2021), no. 20 205116, [arXiv:2010.16414].

[25] P. Gorantla, H. T. Lam, N. Seiberg, and S.-H. Shao, *More Exotic Field Theories in 3+1 Dimensions*, *SciPost Phys.* **9** (2020) 073, [arXiv:2007.04904].

[26] T. Rudelius and S.-H. Shao, *Topological Operators and Completeness of Spectrum in Discrete Gauge Theories*, *JHEP* **12** (2020) 172, [arXiv:2006.10052].

[27] N. Seiberg and S.-H. Shao, *Exotic* $\mathbb{Z}_N$ *Symmetries, Duality, and Fractons in 3+1-Dimensional Quantum Field Theory*, *SciPost Phys.* **10** (2021) 003, [arXiv:2004.06115].

[28] N. Seiberg and S.-H. Shao, *Exotic* $U(1)$ *Symmetries, Duality, and Fractons in 3+1-Dimensional Quantum Field Theory*, *SciPost Phys.* **9** (2020), no. 4 046, [arXiv:2004.00015].

[29] N. Seiberg and S.-H. Shao, *Exotic Symmetries, Duality, and Fractons in 2+1-Dimensional Quantum Field Theory*, *SciPost Phys.* **10** (2021), no. 2 027, [arXiv:2003.10466].

[30] N. Benjamin, H. Ooguri, S.-H. Shao, and Y. Wang, *Twist Gap and Global Symmetry in Two Dimensions*, *Phys. Rev.* **D101** (2020), no. 10 106026, [arXiv:2003.02844].

[31] Y.-H. Lin and S.-H. Shao, *Duality Defect of the Monster CFT*, *J. Phys.* **A54** (2021), no. 6 065201, [arXiv:1911.00042].

[32] C. Córdova, K. Ohmori, S.-H. Shao, and F. Yan, *Decorated* $\mathbb{Z}_2$ *symmetry defects and their time-reversal anomalies*, *Phys. Rev.* **D102** (2020), no. 4 045019, [arXiv:1910.14046].

[33] C.-M. Chang, M. Fluder, Y.-H. Lin, S.-H. Shao, and Y. Wang, *3d N=4 Bootstrap and Mirror Symmetry*, *SciPost Phys.* **10** (2021) 097, [arXiv:1910.03600].

[34] Y.-H. Lin, D. Meltzer, S.-H. Shao, and A. Stergiou, *Bounds on Triangle Anomalies in (3+1)d*, *Phys. Rev.* **D101** (2020), no. 12 125007, [arXiv:1909.11676].

[35] P.-S. Hsin and S.-H. Shao, *Lorentz Symmetry Fractionalization and Dualities in (2+1)d*, *SciPost Phys.* **8** (2020) 018, [arXiv:1909.07383].

[36] W. Ji, S.-H. Shao, and X.-G. Wen, *Topological Transition on the Conformal Manifold*, *Phys. Rev. Res.* **2** (2020), no. 3 033317, [arXiv:1909.01425].

[37] S. Komatsu, R. Mahajan, and S.-H. Shao, *An Index for Quantum Integrability*, *SciPost Phys.* **7** (2019), no. 5 065, [arXiv:1907.07186].

[38] N. Benjamin, H. Ooguri, S.-H. Shao, and Y. Wang, *Light-cone modular bootstrap and pure gravity*, *Phys. Rev.* **D100** (2019), no. 6 066029 (Editors' Suggestion), [arXiv:1906.04184].

[39] Y.-H. Lin and S.-H. Shao, *Anomalies and Bounds on Charged Operators*, *Phys. Rev.* **D100** (2019), no. 2 025013, [arXiv:1904.04833].

[40] N. Arkani-Hamed, Y.-T. Huang, and S.-H. Shao, *On the Positive Geometry of Conformal Field Theory*, *JHEP* **06** (2019) 124, [arXiv:1812.07739].

[41] C. Córdova and S.-H. Shao, *Light-ray Operators and the BMS Algebra*, *Phys. Rev.* **D98** (2018) 125015, [arXiv:1810.05706].

[42] K. Ohmori, N. Seiberg, and S.-H. Shao, *Sigma Models on Flags*, *SciPost Phys.* **6** (2019), no. 2 017, [arXiv:1809.10604].

[43] C.-M. Chang, Y.-H. Lin, S.-H. Shao, Y. Wang, and X. Yin, *Topological Defect Lines and Renormalization Group Flows in Two Dimensions*, *JHEP* **01** (2019) 026, [arXiv:1802.04445].

[44] H. T. Lam and S.-H. Shao, *Conformal Basis, Optical Theorem, and the Bulk Point Singularity*, *Phys. Rev.* **D98** (2018), no. 2 025020, [arXiv:1711.06138].

[45] S. Pasterski, S.-H. Shao, and A. Strominger, *Gluon Amplitudes as 2d Conformal Correlators*, *Phys. Rev.* **D96** (2017), no. 8 085006, [arXiv:1706.03917].

[46] S. Pasterski and S.-H. Shao, *Conformal basis for flat space amplitudes*, *Phys. Rev.* **D96** (2017), no. 6 065022, [arXiv:1705.01027].

[47] C. Córdova, D. Gaiotto, and S.-H. Shao, *Surface Defects and Chiral Algebras*, *JHEP* **05** (2017) 140, [arXiv:1704.01955].

[48] C. Córdova, D. Gaiotto, and S.-H. Shao, *Surface Defect Indices and 2d-4d BPS States*, *JHEP* **12** (2017) 078, [arXiv:1703.02525].

[49] S. Pasterski, S.-H. Shao, and A. Strominger, *Flat Space Amplitudes and Conformal Symmetry of the Celestial Sphere*, *Phys. Rev.* **D96** (2017), no. 6 065026, [arXiv:1701.00049].

[50] Y.-H. Lin, S.-H. Shao, Y. Wang, and X. Yin, *(2, 2) superconformal bootstrap in two dimensions*, *JHEP* **05** (2017) 112, [arXiv:1610.05371].

[51] C. Córdova, D. Gaiotto, and S.-H. Shao, *Infrared Computations of Defect Schur Indices*, *JHEP* **11** (2016) 106, [arXiv:1606.08429].

[52] Y.-H. Lin, S.-H. Shao, D. Simmons-Duffin, Y. Wang, and X. Yin, *$\mathcal{N}$ = 4 superconformal bootstrap of the K3 CFT*, *JHEP* **05** (2017) 126, [arXiv:1511.04065].

[53] Y.-H. Lin, S.-H. Shao, Y. Wang, and X. Yin, *Supersymmetry Constraints and String Theory on K3*, *JHEP* **12** (2015) 142, [arXiv:1508.07305].

[54] C. Córdova and S.-H. Shao, *Schur Indices, BPS Particles, and Argyres-Douglas Theories*, *JHEP* **01** (2016) 040, [arXiv:1506.00265].

[55] M. Esole and S.-H. Shao, *M-theory on Elliptic Calabi-Yau Threefolds and 6d Anomalies*, arXiv:1504.01387.

[56] C. Córdova and S.-H. Shao, *Asymptotics of Ground State Degeneracies in Quiver Quantum Mechanics*, *Commun. Num. Theor. Phys.* **10** (2016) 339–371, [arXiv:1503.03178].

[57] Y.-H. Lin, S.-H. Shao, Y. Wang, and X. Yin, *Higher derivative couplings in theories with sixteen supersymmetries*, *Phys. Rev.* **D92** (2015), no. 12 125017, [arXiv:1503.02077].

[58] C. Córdova and S.-H. Shao, *Counting Trees in Supersymmetric Quantum Mechanics*, *Ann. Inst. H. Poincare Comb. Phys. Interact.* **5** (2018), no. 1 1–60, [arXiv:1502.08050].

[59] Y.-H. Lin, S.-H. Shao, Y. Wang, and X. Yin, *Interpolating the Coulomb Phase of Little String Theory*, *JHEP* **12** (2015) 022, [arXiv:1502.01751].

[60] C.-M. Chang, Y.-H. Lin, S.-H. Shao, Y. Wang, and X. Yin, *Little String Amplitudes (and the Unreasonable Effectiveness of 6D SYM)*, *JHEP* **12** (2014) 176, [arXiv:1407.7511].

[61] M. Esole, S.-H. Shao, and S.-T. Yau, *Singularities and Gauge Theory Phases II*, *Adv. Theor. Math. Phys.* **20** (2016) 683–749, [arXiv:1407.1867].

[62] C. Córdova and S.-H. Shao, *An Index Formula for Supersymmetric Quantum Mechanics*, *Journal of Singularities* **14** (2015) [arXiv:1406.7853].

[63] M. Esole, S.-H. Shao, and S.-T. Yau, *Singularities and Gauge Theory Phases*, *Adv. Theor. Math. Phys.* **19** (2015) 1183–1247, [arXiv:1402.6331].

[64] Y.-H. Lin, S.-H. Shao, Y. Wang, and X. Yin, *A Low Temperature Expansion for Matrix Quantum Mechanics*, *JHEP* **05** (2015) 136, [arXiv:1304.1593].