Zhengwei Liu   Curriculum Vitae

Contact Information:

Birthday:	12/18/1986
Nationality:	China
Address:	Yau Mathematical Science Center, JingZhai 318, Tsinghua University, Beijing, 100084, China
Email:	liuzhengwei@mail.tsinghua.edu.cn
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Dissertation:

Skein theory for subfactor planar algebras (Doctoral dissertation, Vanderbilt University)

Education:

2021-   **Beijing Institute of Mathematical Sciences and Applications**, Associate Director, Adjuct Professor

2019-   **Tsinghua University**, Professor in Mathematics

2015-2019 **Harvard University**, Mathematics and Physics postdoctoral fellow
          Postdoctoral supervisor: Arthur Jaffe

2011-2015 **Vanderbilt University**, Mathematics Ph.D.
          Advisor: Vaughan F.R. Jones

2009-2011 **University of New Hampshire**,

2005-2009 **Peking University**, Mathematics B.S.

Research Interests:

Mathematics and Physics: subfactor theory and their connections with harmonic analysis, knot theory, lower dimensional topology, operator algebras, representation theory, category theory in mathematics; and constructive quantum field theory, conformal field theory, quantum information, condensed matter in physics.

Awards:

- ICCM silver award (2019)
- ICCM best paper award (2018)
- Bjarni Jónsson Prize for Research, Vanderbilt University (2014)

Grants:

Starting Grant from Tsinghua University, 09/2019-09/2022
Templeton Religion Trust 0159, 09/2017-09/2020
AMS-NSF travel grant for 2018 ICM
NSF conference grant 2018
AMS-Simons travel grant, 06/2015-06/2017

Editor:

  2018- A chief editor of the journal Pure and Applied Mathematics Quarterly

Publications:

1. *Composed inclusions of A_3 and A_4 subfactors.* **Advances in Mathematics,** 2015, 279: 307-371
   https://doi.org/10.1016/j.aim.2015.03.017

2. *1-supertransitive subfactors with index at most 6+1/5.* **Communications in Mathematical Physics,** 2015, 334(2): 889-922. (Joint with Scott Morrison and Dave Penneys)
   https://doi.org/10.1007/s00220-014-2160-4

3. *Exchange relation planar algebras of small rank.* **Transactions of the AMS,** 2016, 368(12): 8303-8348.
   https://doi.org/10.1090/tran/6582

4. *Noncommutative uncertainty principles.* **Journal of Functional Analysis,** 2016, 270(1): 264-311. (Joint with Chunlan Jiang and Jinsong Wu)
   https://doi.org/10.1016/j.jfa.2015.08.007

5. *Quon 3D language for quantum information.* **PNAS,** 2017, 114(10): 2947-2502 (Joint with Arthur Jaffe and Alex Wozniakowski)
   doi:10.1073/pnas.1621345114

6. *Planar para algebras, reflection positivity.* **Communications in Mathematical Physics,** 2017, 352(1): 95-133. (Joint with Arthur Jaffe)
   doi:10.1007/s00220-016-2779-4

7. *Singly generated planar algebras of small dimension, part III.* **Transactions of the AMS,** 2017, 369(4): 2461-2476. (Joint with Dietmar Bisch and Vaughan F. R. Jones)
   https://doi.org/10.1090/tran/6719

8. *Uncertainty principles for locally compact quantum groups.* **Journal of Functional Analysis,** 2018, 274(8): 2399-2445 (Joint with Chunlan Jiang and Jinsong Wu)
   https://doi.org/10.1016/j.jfa.2017.09.010

9. *Uncertainty principle for Kac algebras.* **Journal of Mathematical Physics** 2017, 58(5): 052102 (Joint with Jinsong Wu)
   http://dx.doi.org/10.1063/1.4983755

10. *Young's inequality for locally compact quantum groups.* **Journal of Operator Theory,** 2017, 77(1): 109-131. (Joint with Simeng Wang and Jinsong Wu)
    http://dx.doi.org/10.7900/jot.2016mar03.2104

11. *Constructive simulation and topological design of protocols.* **New Journal of Physics,** 2017, 19(6): 063016 (Joint with Arthur Jaffe and Alex Wozniakowski)
    https://doi.org/10.1088/1367-2630/aa5b57

12. *The Noncommutative Fourier Transform: A survey.* **Acta Mathematica Sinica Chinese Series, (In honor of the 75th birthday of Bingren Li)** 2017, 60(1): 69-80. (Joint with Jinsong Wu)
    arXiv:1611.04630

13. *The generator conjecture for 3^G subfactor planar algebras.* **The Proceedings of the Centre for Mathematics and its Applications, Mathematical Sciences Institute, the Australian National University: The Proceedings in honor of Vaughan F. R. Jones' 60th birthday conferences, edited by Scott Morrison and David Penneys** 2017, 46: 344-366 (Joint with Dave Penneys)
    arXiv:1507.04794

14. *Mathematical picture language program.* **PNAS,** 2018, 115(1): 81-86. (Joint with Arthur Jaffe)
    doi:10.1073/pnas.1710707114

15. *Holographic software for quantum networks.* **Science China Mathematics,** 2018, 61 (4): 593-626 (Joint with Arthur Jaffe and Alex Wozniakowski)
doi:10.1007/s11425-017-9207-3

16. *Extremal pairs of Young's inequality for Kac algebras.* **Pacific Journal of Mathematics,** 2018, 295 (1) 103-121. (Joint with Jinsong Wu)
doi:10.2140/pjm.2018.295.103

17. *Block maps and Fourier analysis.* **Science China Mathematics,** 2019, 62(8) 1585-1614 (Joint with Chunlan Jiang and Jinsong Wu)
doi:10.1007/s11425-017-9263-7

18. *Quon Language: Surface Algebras and Fourier Duality.* **Communications in Mathematical Physics,** 2019, 366: 865-894
https://doi.org/10.1007/s00220-019-03361-3

19. *An angle between intermediate subfactors and its rigidity.* **Transactions of the AMS,** 2019, 371: 5973-5991 (Joint with Keshab Bakshi, Sayan Das, and Yunxiang Ren)
https://doi.org/10.1090/tran/7738

20. *Jones-Wassermann subfactors for modular tensor categories.* **Advances in Mathematics,** 2019, 355(15): 106775 (Joint with Feng Xu)
arXiv:1612.08573

21. *Classification of Thurston-relation subfactor planar algebras.* **Quantum Topology,** 2019, 10(3), 441-480 (Joint with Corey Jones and Yunxiang Ren)
doi: 10.4171/QT/126,

22. *Lifting shadings on symmetrically self-dual subfactor planar algebras.* **Contemporary Mathematics,** 2020, 747 (Joint with Scott Morrison and Dave Penneys)
https://doi.org/10.1090/conm/747/15038

23. *De Finetti theorems for braided parafermions.* **Communications in Mathematical Physics,** 2020, 373: 435-456 (Joint with Kaifeng Bu, Arthur Jaffe, Jinsong Wu,)
https://doi.org/10.1007/s00220-019-03579-1

24. *Non-Commutative Rényi entropic uncertainty principles.* **Science China Mathematics,** 2020, 63, 2287-2298. (Joint with Jinsong Wu)
https://doi.org/10.1007/s11425-019-9523-4

25. *Quantum Fourier Analysis* **PNAS** 2020, 117(20): 10715-10720 (Joint with Chunlan Jiang, Arthur Jaffe, Yunxiang Ren and Jinsong Wu)
www.pnas.org/cgi/doi/10.1073/pnas.2002813117

26. *Reflection Positivity and Levin-Wen Models.* Expositiones Mathematicae, a special issue dedicated to Dick Kadison, 2020, 38(2), 202-216 (Joint with Arthur Jaffe,)

27. *A Mathematical Picture Language Project.* to appear 2019 ICCM conference proceedings. (Joint with Arthur Jaffe,)

28. *Antisymmetric characters and Fourier duality.* **Communications in Mathematical Physics,** 2021, 284, 77-108 (Joint with Jinsong Wu,)
https://doi.org/10.1007/s00220-021-04047-5

29. *Fusion Bialgebras and Fourier Analysis.* **Advances in Mathematics,** to appear (Joint with Sebastien Palcoux and Jinsong Wu)
   arXiv:1910.12059

arXiv papers:

1. *Yang-Baxter relation planar algebras.*
   arXiv:1507.06030
2. *Universal Quantum Computation by a Single Photon.* (Joint with Xiaoqin Gao) arXiv:1909.09535
3. *Quantized Graphs and Quantum Error Correction.* arXiv:1910.12065
4. *The adjoint braid arrangement as a combinatorial Lie algebra via the Steinmann relations.* (Joint with William Norledge, Adrian Ocneanu,)
   arXiv:1901.03243
5. *Classification of Grothendieck rings of complex fusion categories of multiplicity one up to rank six.* (joint with Sebastien Palcouxand Yunxiang Ren)
   arXiv:2010.10264
6. *The Grothendieck Ring of a Family of Spherical Categories.* (joint with Christopher Ryba)
   arXiv:2007.05622

International conferences organized:

- Current Progress in Mathematical Physics, 2018 in Harvard, USA (co-organized with Konrad Osterwalder (ETH), Victor Kac (MIT), Christopher King (Northeastern University), Eugene Wayne (Boston University), and Jonathan Weitsman (Northeastern University).)
- Workshop on Quantum Information 2018, CMSA at Harvard, USA (co-organized with Arthur Jaffe and Shing-Tung Yau)
- Subfactor theory, quantum field theory, and quantum information, 2016 in Harvard, USA (co-organized with Arthur Jaffe and Vaughan F. R. Jones)
- Subfactor Theory in Mathematics and Physics 2015 in Qinhuangdao, China (co-organized with Arnaud Brothier, Chunlan Jiang, Vaughan F. R. Jones and Feng Xu)

Conference and seminar talks:

2021

- Tuesday, May 25, Quon Language: Fractional Tensor Network, IIIS seminar, (Tsinghua University)
- Wednesday, May 19, Quantum Fourier Analysis, lecture series of 100th anniversary of Math department, (Nan Kai University)
- Monday, May 17, Quantum Fourier Analysis, Global Noncommutative Geometry Seminar, (Webinar)
- Sunday, May 2, Quantum Fourier Analysis, Jing-Jin-Ji Functional Analysis Conference, (Hebei Normal University)
- Wednesday, April 28, Quon Language: Fractional Tensor Network, SIQSE Invited Talk, (Institute for Quantum Science and Engineering)
- Saturday, April 17, Quantum Fourier Analysis, Forum of Graduate Students, (Tsinghua University)

- Saturday, April 10, Quantum Fourier Analysis, Tsinghua-BIMSA workshop (Beijing Institute of Mathematical Science and Applications)
- Wednesday, March 24, Quantum Fourier Analysis, Beauty of Mathematics Lecture Series, (Tsinghua University)
- Tuesday, March 23, Quantum Fourier Analysis, WALES (Webinar)
- Tuesday, January 05, Brain Storming in Math and Physics–dedicated to Arthur Jaffe, Colloquia & Seminars (AMSS)

2020

- Tuesday, December 29, Subfactors–in Memory of Vaughan Jones, 2020 ICCM plenary lecture (USTC)
- Tuesday, December 22, Brain Storming in Math and Physics–dedicated to Arthur Jaffe, Mathematical Picture Language Seminar (Harvard) online
- Tuesday, December 08, Subfactors–in Memory of Vaughan Jones, Seminar, (Dalian University of Technology) online
- Monday, November 23, Subfactors–in Memory of Vaughan Jones, Math Science Literature Lecture Series, (Harvard and Tsinghua, online
- Thursday, November 5, Subfactors and Quantum Fourier Analysis, seminar, (Tokyo and Kyoto) online
- Tuesday, October 27, Subfactors and Unitary Categorification, seminar, (Nanjing University of Information Science and Technology) online
- Wednesday, October 14, Topological Complexity for Quantum Information, seminar, (DIAS) online
- Friday, September 25, Quantum Fourier Analysis, (Hebei University of Technology)
- Tuesday, June 23, Quantum Fourier Analysis, Mathematical Picture Language Seminar (Harvard) online
- Friday, May 22, Fusion Bialgebras and Fourier Analysis, Subfactor Seminar (Vanderbilt) online
- Thursday, April 16, Quantized Graphs and Quantum Error Corrections, Condensed Matter Physics Seminar (Harvard) online
- Wednesday, Mar 11, Quantized Graphs and Quantum Error Corrections, CMSA (Harvard)
- Friday, Feb 4, Quantized Graphs and Quantum Error Corrections, Mathematical Picture Language Seminar (Harvard)

2019

- Friday, Dec 20, Quantized Graphs and Quantum Error Corrections, Topological Quantum Computing (Shen Zhen)
- Friday, Nov 22, Exceptional Quantum Subgroups, Geometric Group Seminar (Tsinghua University)
- Wednesday, Oct 30, New Spherical Category and Fusion Rules, Subfactors and Applications (Oberwolfach)
- Tuesday, July 23, Quon Language for Quantum Information, Working Group on Quantum Information (AMSS)
- Monday, July 8, New Spherical Categories and Schur-Weyl Duality, International Conference on Representation Theory ICRT8 (Harbin)
- Monday, July 1, Quon Graphs and Quantum Error Corrections, Physics Seminar (ETH)

- Tuesday, June 25, Quantum Graphs and Error Corrections, Mathematical Physics meets Quantum Information Theory (Leysin, Switzerland)
- Friday, June 14, Quantum Fourier Analysis, ICCM (Tsinghua University)
- Tuesday, June 4, Quantum Fourier Analysis, Interactions between Noncommutative Analysis and Quantum Information theory (HIT)
- Tuesday, May 28, Quantum Fourier Analysis, GPOTS plenary lecture (TAMU)
- Thursday, May 9, Quantum Fourier Analysis, NCGOA (Vanderbilt)
- Tuesday, March 19, Quantum Fourier Analysis, Functional Analysis Seminar (UCSD)
- Tuesday, February 5, Geometric Quantum Error-Correcting Codes, Mathematical Physics seminar (Harvard)
- Monday, February 4, A Mathematical Picture Language Project, Higher Category Approach to Certifiably Correct Quantum Information Processing Systems, (Maryland)
- Monday, January 7, Geometric Quantum Error-Correcting Codes, (Hebei Normal University)

2018

- Monday, December 10, Geometric Quantum Error-Correcting Codes, Current Progress in Mathematical Physics, (Harvard)
- Friday, November 2, Schur-Weyl duality for quantum subgroups, (Peking University)
- Friday, October 19, An answer to Kac's question on Coxeter exponents, Fusion categories and subfactors, BIRS, (Banff, Canada)
- Friday, September 14, Quantum Fourier Analysis, Infinite-dimensional algebra seminar, (MIT)
- Friday, September 7, Quantum Fourier Analysis, Colloquium talk, (Tufts University)
- Tuesday, July 24, Topological Design of protocols, IWOTA (Shanghai)
- Thursday, July 19, De Finetti theorems for braided parafermions, (Fudan University & SCMS)
- Friday, July 13, Things we learned in the 2018 Mathematical Picture Language working group!, (AMSS)
- Thursday, July 05, Topological Design of protocols, (AMSS)
- Monday, July 02, (joint talk with Arthur Jaffe), The quon language in quantum information, (Shanghai IAS, USTC)
- Wednesday, June 20, Picture language program, (AMSS)
- Saturday, Apr 22, A new program on quantum subgroups, AMS sectional meeting: Hopf Algebras, Tensor Categories, and Homological Algebra (Boston)
- Sunday, Apr 14, A new program on quantum subgroups, AMS sectional meeting: Advances in Operator Algebras (Vanderbilt University)
- Sunday, March 18, A de Finetti theorem on parafermion algebras, AMS Sectional Meeting: Quantum Symmetries (Columbus, Ohio)
- Wednesday, Feb 14, A new program on quantum subgroups, CMSA colloquium (Harvard)
- Saturday, Jan 12, An angle between intermediate subfactors and its rigidity, AMS Sectional Meeting: Advances in Operator Algebras (San Diego)

2017

- Friday, Dec 08, A new one-parameter centralizer algebra and higher Dynkin diagrams, Infinite-dimensional algebra seminar (MIT)
- Saturday, Sep 30, From subfactors to quantum information and backwards, Shanks workshop: subfactors and applications (Vanderbilt University)

- Tuesday, Sep 05, Introduction to the mathematical picture language project, Mathematical Physics seminar (Harvard)
- Monday, July 17, Fourier analysis on planar algebras, 2017 (Jilin University)
- Tuesday, June 13, Synergy on quon language, Operator algebras: subfactors and their applications (Isaac Newton Institute, Cambridge, UK)
- Monday, May 22, Fourier analysis on planar algebras, Colloquium (Hebei Normal University)
- Friday, May 19, Picture language program, Colloquium (Tsinghua University)
- Tuesday, April 4, Quon language: surface algebras and string Fourier transform, Mathematical Physics seminar (Harvard)
- Saturday, Apr 01, The string Fourier transform on quons, AMS section meeting: special section on fusion categories and applications (Indiana University, Bloomington)
- Monday, Feb 27, Fourier cousins and new planar algebras, 2017 Young Mathematician Forum (Fudan University & SCMS)
- Wednesday, Feb 15, A Fourier cousin of the Birman-Murakami-Wenzl algebra, Yau's geometry seminar (Harvard)
- Tuesday, Feb 02, Quon 3D language for quantum information, Mathematical Physics seminar (Harvard)
- Monday, Jan 08, A new diagrammatic approach to quantum information, Functional analysis and quantum information (Harbin Institute of Technology)
- Thursday, Jan 05, Topological Design of Protocols, Workshop on tensor networks and related problems (Zhejiang University)

2016
- Monday, December 19, Jones-Wasserman subfactors for modular tensor categories, Subfactors and Mathematical Physics: Vaughan Jones (TSIMF)
- Thursday, December 1, A new type of Schur-Weyl duality, Non-Commutative Geometry seminar (Penn State University)
- Monday, November 28, The Fourier transform on subfactors, Non-Commutative Geometry seminar (TAMU)
- Sunday, October 9, A new diagrammatic approach to quantum information, Workshop on subfactor theory, quantum field theory, and quantum information (Harvard)
- Tuesday, September 27, A New Diagrammatic Approach to Quantum Information–the four string model, Mathematical Physics seminar (Harvard)
- Tuesday, September 20, A New Diagrammatic Approach to Quantum Information–the two string model, Mathematical Physics seminar (Harvard)
- Wednesday, August 10, The Fourier transform on subfactors, (Harbin Institute of Technology)
- Thursday, July 7, Planar anionic algebras, at Workshop on von Neumann algebras (HIM)
- Thursday, March 3, New diagrammatic insights in mathematical physics, Mathematical Physics seminar (ETH)
- Wednesday, January 20, Parafermion algebras, subfactors and reflection positivity, Functional Analysis Seminar (UCLA)

2015
- Monday, December 21, Yang-Baxter relation planar algebras, The International Conference on Non-commutative Geometry and K-Theory (Chongqing University)

- Monday, December 21, Fourier Analysis on subfactors, (Chongqing Normal University)
- Friday, October 23, Parasymmetry for subfactors, Subfactor seminar (Vanderbilt University)
- Sunday, October 18, Skein theory for subfactors, AMS section meeting (Memphis)
- Wednesday, October 14, Invariants, subfactors and quantum groups, Colloquium (UC Riverside)
- Saturday, October 10, Skein theory for subfactors, WCOAS (UCSD)
- Saturday, October 3, Skein theory for subfactors, ECOAS (The University of Iowa)
- Wednesday, September 30, Knots, subfactors and quantum groups, Geometry, Physics and Representation theory seminar (North Eastern University)
- Tuesday, September 29, Parafermions, Mathematical Physics seminar (Harvard)
- Thursday, Jul 16, Universal skein theory for subfactors, Subfactor Theory in Mathematics and Physics (in Qinhuangdao)
- Tuesday, May 05, The Classification and Construction of Subfactors, Harvard mathematical physics seminar
- Thursday, Mar 26, A classification with subfactors and fusion categories from CFT, Subfactors and Conformal Field Theory (in Oberwolfach)
- Monday, Jan 12, Noncommutative uncertainty principles, AMS section meeting (in San Antonio)

2014

- Wednesday, December 10, 2014, Noncommutative uncertainty principles, Functional Analysis Seminar, (UCLA)
- Sunday, Oct 21, Noncommutative uncertainty principles, Séminaire d'Analyse Fonctionnelle (Université de Franche-Comté)
- Tuesday, Oct 12, Noncommutative uncertainty principles, The 12th East Coast Operator Algebras Symposium (University of Toronto/ Fields Institute)
- Friday, Aug 22, A universal skein theory for subfactor planar algebras, Vanderbilt subfactor seminar.
- Thursday, Jul 17, Noncommutative uncertainty principles, Subfactor Theory in Mathematics and Physics (in Maui).
- Saturday, Jun 14, Singly generated planar algebras, Operator Algebras and Mathematical Physics (Dalian University of Technology).
- Friday, May 30, Noncommutative uncertainty principles, GPOTS (Kansas State University)
- Friday, Apr 04, Noncommutative uncertainty principles (part II), Vanderbilt subfactor seminar.
- Sunday, Mar 23, Singly generated planar algebras, AMS Sectional Meeting (in Knoxville)
- Friday, Feb 28, Noncommutative uncertainty principles, Vanderbilt subfactor seminar.
- Wednesday, Jan 15, Composed inclusions of subfactors, Joint Mathematics Meetings AMS Special Session (in Baltimore)

2013

- Friday, Nov 22, The subgroup E_{n+2} of quantum $SU(n)$, Vanderbilt subfactor seminar.
- Saturday, Oct 26, Composed inclusions of A_3 and A_4 subfactors, DARPA & Shanks Workshop on Quantum Symmetries (Vanderbilt University)
- Friday, Sep 13, Singly generated planar algebras, Vanderbilt subfactor seminar.
- Thursday, July 18, Composed inclusions of an A_3 and an A_4 subfactor, Subfactors in Maui.

2012

- Friday, July 20, Exchange relation planar algebras, Subfactors in Maui.

Teaching:

2020 fall at Tsinghua University

- Linear Algebras

2019 fall at Tsinghua University

- Calculus 1(A)
- An Introduction to von Neumann Algebras

2017 Lecture at Harvard Univerisity

- Linear algebras

2009-2011 Teaching assistant at University of New Hampshire

- Calculus
- Discrete mathematics

2011-2014 Teaching assistant at Vanderbilt University

- Calculus (150A/B, 155A)

Short Courses:

- Thursday, May 11-30, 2017, Pictures in Mathematics, at Tsinghua Univerisity,
  Lecture 1: From algebras to planar algebras
  Lecture 2: General constructions: Free product and quotient
  Lecture 3: Quantum groups and quantum subgroups
  Lecture 4: Pictorial Fourier analysis
  Lecture 5: Picture language in quantum information
  Lecture 6: Quon language: Fourier duality

- Jun-July, 2018, Introduction to planar algebras, at Tsinghua Univerisity,
  Lecture 1: Planar algebras
  Lecture 2: The classification of Jones index
  Lecture 3: Graph planar algebras
  Lecture 4: The embedding theorem
  Lecture 5: Non-existence of D_{2n-1} and E_7.
  Lecture 6: The A_n, D_{2n}, E_6, E_8 classification