Tian Lan

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The Chinese University of Hong Kong
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Education

2013–2017   PhD in Theoretical Physics
Perimeter Institute for Theoretical Physics & University of Waterloo
Thesis: A Classification of (2+1)D Topological Phases with Symmetries
Supervisor: Xiao-Gang Wen

2012–2013   MSc in Theoretical Physics, Perimeter Scholars International (PSI)
Perimeter Institute for Theoretical Physics & University of Waterloo

2008–2012   BSc in Mathematics and Physics, Tsinghua University

Experience

2018–2020   Postdoctoral Fellow
Institute for Quantum Computing, University of Waterloo
Supervisors: Raymond Laflamme, Bei Zeng

2021.6–now   Assistant Professor
The Chinese University of Hong Kong

Research Interests

My research focuses on the theory of topological phases of matter:

- intrinsic topological order,

- symmetry protected topological (SPT) phases, which include topological insulators as a special case,

- symmetry enriched topological (SET) phases,

- higher dimensional generalization of symmetry and topological phases,

- . . .

and their mathematical foundation:

- tensor category,

- higher category, higher algebra,

- group cohomology, algebraic topology,

- ...

I am also interested in understanding the nature of phases of matter from a quantum information perspective, and possible applications of topological materials such as quantum computing.

Grants

Direct Grant No. 4053501, The Chinese University of Hong Kong
Early Career Scheme (ECS) No. 24304722, Hong Kong Research Grants Council

Teaching

2021-23 Fall	PHYS5410(M) Advanced Quantum Mechanics
2024 Spring	PHYS1111B University Physics I, Introduction to Mechanics, Fluids and Waves

Referee

Physical Review X, Physical Review X Quantum, Physical Review Letters, Physical Review Research, Physical Review B, Journal of High Energy Physics, Scipost, Quantum, Communications in Mathematical Physics.

Editor

Advances in Theoretical and Mathematical Physics.

Awards and Honors

Early Career Award 2021/22, University Grants Committee
2017 Chinese Government Award for Outstanding Self-financed Students Abroad
Scholarship of Tsinghua Xuetang
Scholarship of Tsinghua-Zhenggeru
Scholarship of Shanghai Institute of Microsystem

Talks

- A "Periodic Table" of Topological Orders

    - SIAM Annual Meeting (AN16), Boston, Massachusetts, USA, July, 2016
      invited but was not able to attend due to visa delay
    - Department of Physics, Fudan University, May, 2018
    - Department of Physics, Tsinghua University, July, 2018
    - Graduate School of China Academy of Engineering Physics, July, 2018

- Department of Physics, Southern University of Science and Technology, July, 2019
- The Chinese University of Hong Kong, October, 2020

- Non-Abelian Family of Topological Order[18]

  - Croucher Summer Course "Quantum Entanglement and Topological Order", The Chinese University of Hong Kong, June, 2017
  - Department of Physics, Southern University of Science and Technology, July, 2019

- Matrix Formulation of Non-Abelian Family[10]

  - Topological Quantum Computing (TQC2019), Shenzhen, China, December, 2019

- Higher Dimensional Topological Order, Higher Category and A Classification in 3+1D[11,14]

  - Department of Physics, Tsinghua University, May, 2018
  - Séminaire de mathématiques supérieures (SMS) 2018, Fields Institute for Research in Mathematical Sciences, June, 2018
  - Quantum Information and Operator Algebras III, Academy of Mathematics and Systems Science, Chinese Academy of Sciences, July, 2018
  - Department of Physics, Sun Yat-Sen University, July, 2019
  - QuIST V: The 5th International Conference on Quantum Information, Space-time, and Topological order, Kunming, China, August, 2019
  - Department of Physics, Southern University of Science and Technology, August, 2019
  - The Chinese University of Hong Kong, October, 2020
  - CMSA, Harvard University, June, 2021
  - BIMSA, March, 2022

- The Modular Extension Characterization of SPT/SET Phases[16,17,20]

  - BIMSA, December, 2021

- Introduction to Categorical Approach to Topological Phases in Arbitrary Dimensions

  - Center of Mathematical Sciencies and Applications, Harvard University, April 15, 2020

- Higher symmetry entriched topological phases[7,8]

  - Topological Orders and Higher Structures, Erwin Schrödinger Institute for Mathematics and Physics, University of Vienna, August, 2020

- Quantum Current[2]

  - Croucher Summer Course "Quantum Entanglement and Topological Order", CUHK, June, 2023
  - The first International Congress of Basic Science (ICBS), BIMSA, July, 2023
  - Entangled Quantum Matter Workshop, Tsinghua University, August, 2023

- Gauging of generalized symmetry[4]

  - Mini-Workshop on Unconventional Superconductivity and Correlated Electron Systems, CUHK, Dec, 2023

Publications

[1] Ying Chan, **Tian Lan**, and Linqian Wu, "Torus algebra and logical operators at low energy", 10.48550/ARXIV.2403.01577 (2024), arXiv:2403.01577 [cond-mat.str-el].

[2] **Tian Lan** and Jing-Ren Zhou, "Quantum current and holographic categorical symmetry", SciPost Physics **16**, 053 (2024), arXiv:2305.12917 [cond-mat.str-el].

[3] Gen Yue, Longye Wang, and **Tian Lan**, "Condensation completion and defects in 2+1d topological orders", 10.48550/ARXIV.2402.19253 (2024), arXiv:2402.19253 [cond-mat.str-el].

[4] **Tian Lan**, Gen Yue, and Longye Wang, "Gauging of generalized symmetry", 10.48550/ARXIV.2312.15958 (2023), arXiv:2312.15958 [cond-mat.str-el].

[5] Wenjie Xi, **Tian Lan**, Longye Wang, Chenjie Wang, and Wei-Qiang Chen, "On a class of fusion 2-category symmetry: condensation completion of braided fusion category", 10.48550/ARXIV.2312.15947 (2023), arXiv:2312.15947 [hep-th].

[6] Wenjie Xi, Ya-Lei Lu, **Tian Lan**, and Wei-Qiang Chen, "A lattice realization of general three-dimensional topological order", 10.48550/ARXIV.2110.06079 (2021), arXiv:2110.06079 [cond-mat.str-el].

[7] Liang Kong, **Tian Lan**, Xiao-Gang Wen, Zhi-Hao Zhang, and Hao Zheng, "Algebraic higher symmetry and categorical symmetry: a holographic and entanglement view of symmetry", Physical Review Research **2**, 043086 (2020), arXiv:2005.14178 [cond-mat.str-el].

[8] Liang Kong, **Tian Lan**, Xiao-Gang Wen, Zhi-Hao Zhang, and Hao Zheng, "Classification of topological phases with finite internal symmetries in all dimensions", Journal of High Energy Physics **2020**, 93 (2020), arXiv:2003.08898 [math-ph].

[9] **Tian Lan**, Xueda Wen, Liang Kong, and Xiao-Gang Wen, "Gapped domain walls between 2+1D topologically ordered states", Physical Review Research **2**, 023331 (2020), arXiv:1911.08470.

[10] **Tian Lan**, "Matrix formulation for non-Abelian families", Physical Review B **100**, 241102(R) (2019), arXiv:1908.02599.

[11] **Tian Lan** and Xiao-Gang Wen, "Classification of 3+1D bosonic topological orders (II): the case when some pointlike excitations are fermions", Physical Review X **9**, 021005 (2019), arXiv:1801.08530.

[12] **Tian Lan**, Chenchang Zhu, and Xiao-Gang Wen, "Fermion decoration construction of symmetry-protected trivial order for fermion systems with any symmetry and in any dimension", Physical Review B **100**, 235141 (2019), arXiv:1809.01112.

[13] Chenchang Zhu, **Tian Lan**, and Xiao-Gang Wen, "Topological nonlinear σ-model, higher gauge theory, and a systematic construction of 3+1D topological orders for boson systems", Physical Review B **100**, 045105 (2019), arXiv:1808.09394.

[14] **Tian Lan**, Liang Kong, and Xiao-Gang Wen, "Classification of 3+1D bosonic topological orders: the case when pointlike excitations are all bosons", Physical Review X **8**, 021074 (2018), arXiv:1704.04221.

[15] **Tian Lan**, "A classification of (2+1)D topological phases with symmetries", PhD thesis (University of Waterloo, Sept. 2017), p. 86, arXiv:1801.01210 [cond-mat.str-el].

[16] **Tian Lan**, Liang Kong, and Xiao-Gang Wen, "Classification of (2+1)-dimensional topological order and symmetry-protected topological order for bosonic and fermionic systems with on-site symmetries", Physical Review B **95**, 235140 (2017), arXiv:1602.05946.

[17] **Tian Lan**, Liang Kong, and Xiao-Gang Wen, "Modular extensions of unitary braided fusion categories and 2+1D topological/SPT orders with symmetries", Communications in Mathematical Physics **351**, 709–739 (2017), arXiv:1602.05936.

[18] **Tian Lan** and Xiao-Gang Wen, "Hierarchy construction and non-Abelian families of generic topological orders", Physical Review Letters **119**, 040403 (2017), arXiv:1701.07820.

[19] Keren Li, Yidun Wan, Ling-Yan Hung, **Tian Lan**, Guilu Long, Dawei Lu, Bei Zeng, and Raymond Laflamme, "Experimental identification of non-Abelian topological orders on a quantum simulator", Physical Review Letters **118**, 080502 (2017), arXiv:1608.06932.

[20] **Tian Lan**, Liang Kong, and Xiao-Gang Wen, "Theory of (2+1)-dimensional fermionic topological orders and fermionic/bosonic topological orders with symmetries", Physical Review B **94**, 155113 (2016), arXiv:1507.04673.

[21] **Tian Lan**, Juven C. Wang, and Xiao-Gang Wen, "Gapped domain walls, gapped boundaries, and topological degeneracy", Physical Review Letters **114**, 076402 (2015), arXiv:1408.6514.

[22] **Tian Lan** and Xiao-Gang Wen, "Topological quasiparticles and the holographic bulk-edge relation in (2+1)-dimensional string-net models", Physical Review B **90**, 115119 (2014), arXiv:1311.1784.