Guo Chuan Thiang, DPhil

EDUCATION

University of Oxford, Balliol College

DPhil Mathematics, Oct 2011 - Dec 2014 (conferred March 2016)

University of Cambridge, Churchill College

MASt in Mathematics, Distinction, Oct 2010 - June 2011

National University of Singapore

Bachelor of Science (First Class Honours), Physics and Mathematics, Aug 2006 - Dec 2009

EMPLOYMENT

Peking University, Beijing International Center for Mathematical Research, China, late 2020 onwards

Assistant Professor

University of Adelaide, Australia

Australian Research Council DECRA Fellow, 1 April 2017–2020
Post-doctoral Research Associate, 7 Jan 2015 – 31 Mar 2017

Centre for Quantum Technologies, Singapore

Research Assistant, Jan 2010 - Sept 2010

VISITING POSITIONS

Simons Center for Geometry and Physics, Stony Brook University, May–June 2017
Australian National University, Visiting Fellow, May 2015.

COMPETITIVE RESEARCH GRANTS (POST-DOCTORAL)

- 2020-2022: Chief Investigator, with V. Mathai and P. Hochs, Australian Research Council Discovery Project, $507,000.
  Project: *Coarse Geometry: a novel approach to the Callias index & topological matter*.
- 2017-2019: Australian Research Council Discovery Early Career Researcher Award (DECRA), $357,000.
  Project: *T-duality and K-theory: Unity of condensed matter and string theory*.
- 2017-2019: Office of the Deputy Vice-Chancellor (Research) Establishment Grant, Uni. Adelaide. $25,000.
- 2018: University of Adelaide Vice-Chancellor's Research Fellowship, 1-year salary and $10,000 grant.
  Project: *Mathematics at the Intersection of string theory and topological materials*.
- 2016: AMSI and AustMS conference funding. $10,139, 2016
  Conference: *Topological matter, strings, K-theory, and related areas*.

AWARDS (POSTGRADUATE)

- Clarendon Fund Scholarship, University of Oxford, 2011–2014
- Balliol College JT Hamilton Scholarship in Mathematics, 2011–2014
- Churchill College Prize Scholarship, University of Cambridge, 2011
- Cambridge Commonwealth Trust Scholarship, 2010–2011

AWARDS (UNDERGRADUATE)

- Institute of Physics Medal (Best Honours undergraduate), 2010
- Lijen Industrial Development Medal for best Honours academic project, 2010
- Outstanding Undergraduate Researcher Award (Individual), 2010

Online Research Profiles

- Google Scholar profile
- ORCID: 0000-0003-0268-0065
- University Profile: https://researchers.adelaide.edu.au/profile/guochuan.thiang

Publication List

Pre-prints:

1. K. Gomi, Y. Kubota, G.C. Thiang, *Twisted crystallographic T-duality via the Baum–Connes isomorphism*.
2. M. Ludewig, G.C.Thiang, *Gaplessness of Landau Hamiltonians on hyperbolic half-planes via coarse geometry*. [arXiv:2009.07688]
3. A. Carey, G.C. Thiang, *The Fermi gerbe of Weyl semimetals*. [arXiv:2009.07688]
4. M. Ludewig, G.C. Thiang, *Cobordism invariance of topological edge-following states* [arXiv:2001.08339]

Refereed publications:

5. G.C. Thiang, *On spectral flow and Fermi arcs.*
   Communications in Mathematical Physics (accepted). [arXiv:2007.06193]
6. G.C. Thiang, *Edge-following topological states.*
   Journal of Geometry and Physics, **156** 103796 (2020). [arXiv:1908.09559]
7. M. Ludewig, G.C. Thiang, *Good Wannier bases in Hilbert modules associated to topological insulators*.
   Journal of Mathematical Physics, **61** 061902 (2020). [arXiv:1904.13051]
8. V. Mathai and G.C. Thiang, *Topological phases on the hyperbolic plane: fractional bulk-boundary correpondence*.
   Advances in Theoretical and Mathematical Physics, **23**(3) 803–840 (2019). [arXiv:1712.02952]
9. K. Yamamoto, G.C. Thiang, P. Pirro, K.-W. Kim, K. Everschor-Sitte, E. Saitoh, *Topological characterization of classical waves: the topological origin of magnetostatic surface spin waves*.
   Physical Review Letters, **122** 217201 (2019). [arXiv:1905.07907]
10. K. Gomi and G.C. Thiang, *Crystallographic T-duality*.
    Journal of Geometry and Physics, **139** 50–77 (2019). [arXiv:1806.11385]
11. K. Gomi and G.C. Thiang, *Crystallographic bulk-edge correspondence: glide reflections and twisted mod 2 indices*.
    Letters in Mathematical Physics, **109**(4) 857–904 (2019). [arXiv:1804.03945]
12. K.C. Hannabuss, V. Mathai and G.C. Thiang, *T-duality simplifies bulk-boundary correspondence: the noncommutative case*.
    Letters in Mathematical Physics, **108**(5) 1163–1201 (2018). [arXiv:1603.00116]
13. G.C. Thiang, K. Sato, and K. Gomi, *Fu–Kane–Mele monopoles in semimetals*.
    Nuclear Physics B, **923** 107–125 (2017). [arXiv:1705.06657]
14. V. Mathai and G.C. Thiang, *Differential topology of semimetals*.
    Communications in Mathematical Physics, **355**(2) 561–602 (2017). [arXiv:1611.08961]

15. V. Mathai and G.C. Thiang, *Global topology of Weyl semimetals and Fermi arcs*.
Journal of Physics A: Mathematical and Theoretical (Letter), **50**(11) 11LT01 (2017).
Publicity at JPhys+, [arXiv:1607.02242]

16. K.C. Hannabuss, V. Mathai and G.C. Thiang, *T-duality simplifies bulk-boundary correspondence: the parametrised case*.
Advances in Theoretical and Mathematical Physics, **20**(5) 1193–1226 (2016). [arXiv:1510.04785]

17. V. Mathai and G.C. Thiang, *T-duality simplifies bulk-boundary correspondence: some higher dimensional cases*.
Annales Henri Poincaré, **17**(12) 3399–3424 (2016). [arXiv:1506.04492]

18. V. Mathai and G.C. Thiang, *T-duality simplifies bulk-boundary correspondence*.
Communications in Mathematical Physics, **345**(2) 675–701 (2016). [arXiv:1505.05250]

19. G.C. Thiang, *On the K-theoretic classification of topological phases of matter*.
Annales Henri Poincaré, **17**(4) 757–794 (2016). [arXiv:1406.7366]

20. V. Mathai and G.C. Thiang, *T-duality of Topological Insulators*.
Journal of Physics A: Mathematical and Theoretical (Fast Track Communication), **48** 42FT02 (2015).
Publicity at IOPSCIENCE, [arXiv:1503.01206]

21. G.C. Thiang, *Topological phases: isomorphism, homotopy and K-theory*.
International Journal of Geometric Methods in Modern Physics, **12** 1550098 (2015). [arXiv:1412.4191]

22. G.C. Thiang, *Degree of Separability of Bipartite Quantum States*.
Physical Review A, **82**(1) 012332 (2010). [arXiv:1005.3675]

23. G.C. Thiang, P. Raynal, and B.-G. Englert, *Optimal Lewenstein–Sanpera Decomposition for two-qubit states using Semidefinite Programming*.
Physical Review A, **80**(5) 052313 (2009). [arXiv:0909.4599]

REFEREED CONFERENCE PROCEEDINGS:

24. G.C. Thiang, *T-duality and K-theory: a view from condensed matter physics*.
In: *Noncommutative Geometry and Physics IV*, proceedings for TFC thematic year 2015 on "Strings, Black Holes and Quantum Information" (2017).

25. G.C. Thiang, *On the K-theoretic classification of topological phases of matter (conspectus)*.
In: Proceedings of Frontiers of Fundamental Physics 14 (2014).

EDITED VOLUME:

26. V. Mathai, G.C. Thiang, P. Hekmati, H. Bursztyn, P. Bouwknegt, D. Baraglia,
String geometries, dualities and topological matter.
Journal of Geometry and Physics **138** (2019).

INVITED CONFERENCE TALKS AND LECTURES

- Workshop on Topological phases, Australian National University, 2021.
- C^*-algebras, K-theories and Noncommutative Geometries of Correlated Condensed Matter Systems, Simons Center for Geometry and Physics, May 2021.
- *Coarse index and spectral flow methods for topological matter*
  Mathematics of topological insulators, Columbia University, November 2020.
- *Mathematical unity in topological matter*
  Colloquium, Australian National University, Oct 2020.
- *Spectral aspects of topological matter with an eye on strings*
  Australia and New Zealand Geometry, Strings and Fields Seminar series, Sept 2020.
- *K-theory and index theory of edge-following states in topological insulators*
  Invited lecture series, Autumn Operator Algebras Program, East China Normal University, Oct 2019.
- *Edge-following topological states*
  Analysis on Manifolds, University of Adelaide, October 2019.
- *Unity of pure mathematics in topological materials*
  Meeting of Minds @ HKU Forum, University of Hong Kong, October 2019.
- *Topological quantum chemistry and the Baum-Connes conjecture*,
  Noncommutative Calculus and the Spectral Action, UNSW, Sydney, August 2019.
- *Duality techniques for topological matter*,
  Progress in the Mathematics of Topological States of Matter, Tohoku University, Sendai, August 2019.
- *Hilbert modules and K-theory in quantum chemistry*,
  Index Theory, Duality and Related Fields, Chern Institute of Mathematics, Tianjin, June 2019.
- *(Non)-existent atomic limits: geometric meaning of K-theory in the solid-state,*
  Topological Phases of Interacting Quantum Systems, Banff Int. Research Station, Oaxaca, June 2019.
- *T-duality methods in topological matter*,
  String and M-Theory: The New Geometry of the 21st Century, National Univ. Singapore, Dec 2018.
- *Crystallographic T-duality and super-Baum–Connes conjecture*,
  Bivariant K-theory in Geometry and Physics, Erwin Schrödinger Institute, Nov 2018.
- *Duality Methods for Topological Phases*,
  Recent progress in mathematics of topological insulators, ETH Zürich, Sept 2018.
- *Index theorems from crystallographic bulk-boundary correspondence*,
  Solid Math 2018, McGill University, Aug 2018.
- *Twisted mod 2 index from crystallography*,
  Index theory and applications to positive scalar curvature and related areas, Univ. Adelaide, June 2018.
- *Crystallographic T-duality and the bulk-boundary correspondence principle*,
  Noncommutative Geometry and Representation Theory, Tianyuan Math. Center, Sichuan, May 2018.
- *K-theory and T-duality in topological phases*,
  NCTS Lecture series on Topology & Condensed Matter, National Tsinghua University, March 2018.
- *K-theory and T-duality of topological phases*,
  Intensive seminars on topological insulators and K-theory, Seoul National University, February 2018.
- *Hyperbolic topological phases and fractional bulk-boundary correspondence*,
  Bulk-Edge Correspondence 2018, University of Tsukuba, Jan 2018.
- *Time-reversal in topological semimetals*,
  Strongly correlated topological phases of matter, Simons Center for Geometry and Physics, Stony Brook, June 2017.
- *Time-reversal and semimetals*,
  Mathematical aspects of disordered systems, ETH Zurich, June 2017.
- *Topological Fourier transforms and K-theory in physics*,
  KK-theory, Gauge Theory and Topological Phases Workshop, Lorentz Center, Leiden, Mar 2017.

- Lecture series on *Symmetries, topological phases, and K-theory*,
  Lorentz Center, Leiden, Feb–Mar 2017.
- *The differential topology of semimetals*,
  Second Australia–Japan Geometry, Analysis and their Applications, Kyoto University, Feb 2017.
- *The solid state of K-theory*,
  International conference in K-theory, Western Sydney Univ., Aug 2016.
- *The solid state of K-theory*,
  Refining C^*-algebraic invariants for dynamics using KK-theory, University of Melbourne, July 2016.
- *T-duality and (real) K-theory: a view from condensed matter physics*,
  Higher structures in string theory and M-theory, Tohoku University, Mar 2016.
- *T-duality, K-theory, and bulk-boundary correspondence for topological phases*,
  Higher structures in string theory and quantum field theory, Erwin Schrödinger Institute, Dec 2015.
- *K-theory as obstructions between topological phases*,
  Workshop on topological states and non-commutative geometry, AIMR Tohoku University, March 2015.
- *On the K-theoretic classification of topological phases of matter*,
  Frontiers of Fundamental Physics 14, Aix Marseille University, July 2014.
- *Degree of Separability of Bipartite Quantum States*,
  International Conference on Quantum Optics and Quantum Information, Kyiv, Ukraine, May–June 2010.

OTHER TALKS

- Invited seminars at Shanghai Jiao Tong University, East China Normal University, Hong Kong University, Beijing International Center for Mathematical Research, Tohoku University, Shinshu University, Pontificia Universidad Católica De Chile, Sapienza University of Rome, University of Melbourne, University of Wollongong, Australian National University, University of Oxford, National University of Singapore, Max-Planck Institute of Quantum Optics
- Contributed talks to Annual Meetings of AustMS (2015-2019), ANZAMP (2017,2019,2020).

RESEARCH BACKGROUND

My research expertise is in K-theory, operator algebras, algebraic topology, noncommutative geometry, and index theory, as applied to mathematical physics problems arising in:

- Topological phases of matter
- Mathematical dualities in condensed matter physics and string theory
- Geometric analysis and index theory for Bulk-Boundary Correspondences

I have also worked on the mathematics of quantization and quantum field theory, quantum information theory, convex optimization techniques, and foundations of quantum mechanics.

TEACHING AND SUPERVISION

- PhD co-supervisor for Johnny Lim (Dean's Commendation; Elsevier Young Scientist Award for best student talk at *Index Theory, Duality and Related Fields* conference 2019).
  University of Adelaide 2018-20.
- Lecturer and course coordinator for *Functional analysis*, Honours/Masters course.
  University of Adelaide 2019.
- Lecturer and course coordinator for *Introduction to K-theory*, brand new Honours/Masters course.
  University of Adelaide, 2018.
- Tutor for Linear programming.
  University of Oxford, 2014.
- Teaching assistant for a variety of first-year mathematics courses:
  Calculus, Probability, Dynamics, Fourier series and PDEs, Statistics, Vector Calculus, Optimisation,

Geometry.
University of Oxford, 2012-2014.

- Teaching assistant for Third-year Electromagnetism and Quantum Mechanics.
  University of Oxford, 2012.

PROFESSIONAL SERVICE

Guest editor

J. Geometry and Physics, Special Issue on *String Geometries, Dualities, and Topological Matter*.

Journal reviewer

Communications in Mathematical Physics
International Journal of Mathematics
Communications in Analysis and Geometry
Annales Henri Poincaré
Letters in Mathematical Physics
Symmetry, Integrability and Geometry: Methods and Applications
Journal of Physics A: Mathematical and Theoretical
MATRIX Institute Book Series
International Journal of Quantum Information
Journal of Geometry and Physics (*selected as one of the most valued reviewers 2017*)

Conference organisation

62nd Annual Meeting of the Australian Mathematical Society, 4–7 December 2018
Australia–China conference in noncommutative geometry and related areas, 18–22 December 2017
Gauge theory and higher geometry, 28 Nov–1 Dec 2017
String Dualities and Geometries, 11–15 September 2017
Topological matter, strings, K-theory, and related areas, 26–30 September 2016
Australia–Japan Geometry, Analysis and their applications, 19–23 October 2015

Seminar organisation

Convenor of Differential Geometry Seminar, University of Adelaide, 2018–2020