Hanmeng (Harmony) Zhan

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Research Interests Algebraic graph theory, quantum walks, orthogonal polynomials, equiangular lines, association schemes, covering graphs, graph embeddings

Current Position

Postdoctoral Fellow January 2022 - Present

- Department of Mathematics, Simon Fraser University, Vancouver, BC, Canada
  Supervisor: Bojan Mohar

Previous Positions

York Science Fellow Oct 2019 - September 2021

- Department of Mathematics and Statistics, York University, Toronto, ON, Canada
  Supervisor: Ada Chan

Postdoctoral Fellow Oct 2018 - Sep 2018

- Centre de Recherches Mathématiques, Université de Montréal, Montréal, QC, Canada
  Supervisor: Luc Vinet

Education

University of Waterloo, Waterloo, ON, Canada

- Ph.D. May 2014 - Sep 2018
  Department of Combinatorics and Optimization, Faculty of Mathematics
  Thesis: *Discrete Quantum Walks on Graphs and Digraphs*
  Supervisor: Chris Godsil
  Thesis awards:
  - University Finalist for the Governor General's Gold Medal
  - Inaugural Mathematics Doctoral Prize
- Master of Mathematics Sep 2012 - Apr 2014
  Department of Combinatorics and Optimization, Faculty of Mathematics
  Thesis: *Uniform Mixing on Cayley Graphs over* $\mathbb{Z}_3^d$
  Supervisor: Chris Godsil
  Thesis award:
  - Outstanding Achievement in Graduate Studies
- Bachelor of Arts Jan 2010 - Aug 2012
  Department of Economics, Faculty of Arts
  Thesis: *Second-Price Auction with Resale*
  Supervisor: Philip Curry

Xiamen University, Xiamen, Fujian, China

- Bachelor of Economics Sep 2008 - Jun 2014
  Department of Statistics, Faculty of Economics
  Thesis: *Multi-Player Multi-State Quantum Games*
  Supervisor: Zhengming Qian

PUBLICATIONS

Journal Publications

1. H. Zhan, *Factoring discrete quantum walks on distance regular graphs into continuous quantum walks.* Linear Algebra and its Applications (2022), 648: pp 88103. doi:10.1016/J.LAA.2022.04.017

2. A. Chan, B. Johnson, M. Liu, M. Schmidt, Z. Yin, H. Zhan, *Laplacian pretty good fractional revival.* Discrete Mathematics (2022), 345(10), 112971. doi:10.1016/J.DISC.2022.112971

3. A. Chan, B. Johnson, M. Liu, M. Schmidt, Z. Yin, H. Zhan, *Laplacian fractional revival on graphs.* Electronic Journal of Combinatorics (2021) 28(3): P3.22.

4. A. Chan, G. Coutinho, C. Tamon, L. Vinet, H. Zhan, *Fractional revival and association schemes.* Discrete Mathematics (2020) 343(11), 112018. doi:10.1016/j.disc.2020.112018

5. L. Vinet, H. Zhan, *Perfect state transfer on weighted graphs of the Johnson scheme.* Letter in Mathematical Physics (2020). doi.org/10.1007/s11005-020-01298-6

6. H. Zhan, *Quantum walks on embeddings.* Journal of Algebraic Combinatorics (2020). doi.org/10.1007/s10801-020-00958-z

7. H. Zhan, *An infinite family of circulant graphs with perfect state transfer in discrete quantum walks.* Quantum Information Processing (2019) 18(12): pp. 369.

8. G. Coutinho, L. Vinet, H. Zhan, A. Zhedanov. *Perfect state transfer in a spin chain without mirror symmetry.* Journal of Physics A: Mathematical and Theoretical (2019) 52(45), pp. 455302.

9. C. Godsil, H. Zhan, *Discrete-time quantum walks and graph structures.* Journal of Combinatorial Theory, Series A (2019), pp. 181212.

10. A. Chan, G. Coutinho, C. Tamon, L. Vinet, H. Zhan, *Quantum fractional revival on graphs.* Discrete Applied Mathematics (2019) 269, pp. 86-98.

11. G. Coutinho, C. Godsil, K. Guo, H. Zhan, *A new perspective on the average mixing matrix.* Electronic Journal of Combinatorics (2018) 25(4): P4.14.

12. C. Godsil, H. Zhan, *Uniform mixing on Cayley graphs.* Electronic Journal of Combinatorics (2017) 24(3): P3.20.

13. G. Coutinho, C. Godsil, M. Shirazi, H. Zhan, *Equiangular lines and covers of the complete graph.* Linear Algebra and its Applications (2016) 488: pp. 264-283.

14. R. Alvir, S. Dever, B. Lovitz, J. Myer, C. Tamon, Y. Xu, H. Zhan. *Perfect state transfer in Laplacian quantum walk.* Journal of Algebraic Combinatorics (2016) 43(4): pp. 801-826.

Preprints

15. Q. Chen, C. Godsil, M. Sobchuk, H. Zhan. *Hamiltonians of Bipartite Walks.* arXiv:2207.01673 (2022).

16. A. Chan, H. Zhan, *Pretty good state transfer in discrete-time quantum walks.* arXiv:2105.03762 (2021).

17. H. Zhan, *The average search probabilities of discrete-time quantum walks.* arXiv:2108.09818 (2021). Submitted.

18. A. Chan, G. Coutinho, W. Drazen, O. Eisenberg, C. Godsil, G. Lippner, M. Kempton, C. Tamon, H. Zhan, *Fundamentals of fractional revival in graph.* arXiv:2004.01129 (2020). Submitted.

Book

19. C. Godsil, H. Zhan, *Discrete Quantum Walks.* Accepted by Cambridge University Press.

Supervision Experience

Undergraduate Research Programs

- Fields Undergraduate Summer Research Program Jul 2 - Aug 28, 2020
  Co-supervised an undergraduate research project with Ada Chan on Laplacian fractional revival. This results in two papers [2] and [3]. One student was awarded the Book Prize by the Fields Institute.

Presentations

Invited Talks

1. *The average search probability in a quantum walk with an oracle.* In: Algebraic Graph Theory Seminar, University of Waterloo, Waterloo, ON, Canada, August 2, 2021.
2. *Arc-reversal quantum walks.* In: Discrete Math Seminar, Simon Fraser University, Vancouver, BC, Canada, February 24, 2021.
3. *DRACKNs and their applications in quantum information.* In: Codes and Expansions, United States, September 8, 2020.
4. *Factoring discrete quantum walks into continuous quantum walks.* In: Algebraic Graph Theory Seminar, University of Waterloo, Waterloo, ON, Canada, August 3, 2020.
5. *Quantum fractional revival.* In: Discrete Math Seminar, University of Delaware, Newark, DE, United States, April 23, 2020.
6. *New advances in quantum walks.* In: AMS Joint Mathematics Meetings, Colorado Convention Center, Denver, CO, United States, January 15 - 18, 2020.
7. *State transfer via orthogonal polynomials.* In: AMS Sectional Meeting, University of Wisconsin-Madison, Madison, WI, United States, September 14 - 15, 2019.
8. *Quantum state transfer in the algebra of the Johnson scheme.* In: CMS Summer Meeting, University of Regina, Regina, SK, Canada, June 7 - 10, 2019.
9. *Some elegant results in algebraic graph theory.* In: Canadian Discrete and Algorithmic Mathematics Conference, Simon Fraser University, Vancouver, BC, Canada, May 28 - 31, 2019.
10. *Quantum walks, orthogonal polynomials, and spectral graph theory.* In: Quantum Walks and Information Tasks, Banff International Research Station for Mathematical Innovation and Discovery, Banff, AB, Canada, April 21 - 26, 2019.
11. *Generating entanglement using quantum walks.* In: David A. Walsh Seminar Series, Clarkson University, Potsdam, NY, United States, February 8, 2019.
12. *Some open problems in discrete quantum walks.* In: Algebraic Graph Theory and Quantum Walks, University of Waterloo, Waterloo, ON, Canada, April 23 - 27, 2018.

13. *Recent progress in discrete quantum walks.* In: AMS Sectional Meeting, Northeastern University, Boston, MA, United States, April 21 - 22, 2018, 2018.

14. *Graph covers and equiangular frames.* In: AMS Sectional Meeting, Ohio State University, Columbus, OH, United States, March 16 - 18, 2018.

15. *From covers to tight frames.* In: AMS Sectional Meeting, College of Charleston, Charleston, SC, United States, March 10 - 12, 2017.

16. *Spectra of discrete quantum walks.* In: CMS Summer Meeting, University of Alberta, Edmonton, AB, Canada, June 24 - 27, 2016.

17. *Lines and covers of complete graphs 2.* In: Systems of Lines: Applications of Algebraic Combinatorics, Worcester Polytechnic Institute, Worcester, MA, United States, August 10 - 14, 2015.

18. *Some open problems in uniform mixing.* In: Summer Research Program, Clarkson University, Potsdam, NY, United States, July 20, 2015.

Conference Talks

1. *How far can the quantum walker go.* In: 9th International Conference on Quantum Simulation and Quantum Walks, Centre International de Rencontres Mathématiques, Marseille, Bouches-du-Rhone, France, January 20 - 24, 2020.

2. *Discrete quantum walks on Cayley graphs.* In: CMS Winter Meeting, York University, Toronto, ON, Canada, December 6 - 9, 2019.

3. *The vertex-face walk.* In: Finite Geometry and Extremal Combinatorics, University of Delaware, Newark, DE, United States, August 21 - 24, 2019.

4. *Combinatorial aspects of quantum walks.* In: Prairie Discrete Math Workshop, Brandon University, Brandon, MB, Canada, June 12 - 15, 2018.

5. *Discrete-time quantum walks and graph embeddings.* In: CMS Winter Meeting, University of Waterloo, Waterloo, ON, Canada, December 8 - 11, 2017.

6. *Quantum walks and mixing.* In: Algebraic and Extremal Graph Theory, University of Delaware, Newark, DE, United States, August 7 - 10, 2017.

7. *Discrete-time quantum walks and graph structures.* In: Canadian Discrete and Algorithmic Mathematics Conference, Ryerson University, Toronto, ON, Canada, June 12 - 15, 2017.

8. *Uniform mixing in quantum walks.* In: 22nd Ontario Combinatorics Workshop, York University, Toronto, ON, Canada, May 16 - 17, 2014.

Teaching Experience

Simon Fraser University

- Instructor — Summer 2022
  MATH 240: Algebra I: Linear Algebra (class size: 90)

Online Graduate Courses

- Instructor — Winter 2021
  Combinatorics and Quantum Walks

York University

- Instructor — Winter 2020, Fall 2020
  MATH 1014: Applied Calculus II (class size: 180 - 280)

University of Waterloo

- Instructor — Winter 2018
  MATH 135: Algebra for Honors Mathematics (class size: 60)
- Substitute Instructor — Winter 2017
  CO 444/644: Algebraic Graph Theory (class size: 20)
- Teaching Assistant — 2012 – 2017

Algebraic Enumeration	Algebraic Graph Theory
Calculus	Coding Theory
Introduction to Graph Theory	Graph Theory
Introduction to Combinatorics	Linear Algebra
Portfolio Optimization Models	Special Topics in Mathematical Connections

Service

Conference, Workshop and Seminar Organizer

- Algebraic Graph Theory and Quantum Information, Fields Institute — 2021
- Quantum Information on Graphs, CMS Winter Meeting — Dec 6 - 9, 2019
- Discrete Mathematics Seminar, York University — Fall, 2019
- Algebraic Graph Theory Seminar, University of Waterloo — Spring 2016, Fall 2017

Journal Refereeing

- Communications in Algebra
- Discrete Mathematics
- Electronic Journal of Combinatorics
- Journal of Combinatorial Theory A
- Journal of Physics A: Mathematical and Theoretical
- Linear Algebra and Its Applications
- Linear and Multilinear Algebra

Conference Refereeing

- International Colloquium on Automata, Languages and Programming
- Sampling Theory and Applications

Awards and Distinctions

University of Waterloo

- University Finalist for the Governor General's Gold Medal — 2019
- Inaugural Mathematics Doctoral Prize — 2019
- Outstanding Achievement in Graduate Studies — 2015
- Cotton Family Women in Mathematics Graduate Scholarship — 2014, 2016, 2017
- Faculty of Arts Upper-Year Scholarship — 2011-2012

- Robin K. Banks Scholarship 2011-2012
- Dean's Honours List 2011-2012