

# Pui-Tung (Gary) Choi

Department of Mathematics, Massachusetts Institute of Technology

## PERSONAL INFORMATION

Address: Room 2-177, Department of Mathematics, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02139, USA  
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Website: <https://math.mit.edu/~ptchoi>  
ORCID: 0000-0001-5407-9111

## EMPLOYMENT

**Massachusetts Institute of Technology**, Cambridge, MA, USA  
▪ **NSF Postdoctoral Fellow and Instructor in Applied Mathematics** 2020–Present  
• Mentor: [Jörn Dunkel](#)

## EDUCATION

**Harvard University**, Cambridge, MA, USA  
▪ **Ph.D. in Applied Mathematics** 2016–2020  
• Advisors: [L. Mahadevan FRS](#) and [Chris Rycroft](#)  
• Dissertation: “[Metamaterials, Morphometrics, Morphogenesis, and Mappings](#)”  
▪ **S.M. in Applied Mathematics** 2019  
**The Chinese University of Hong Kong**, Hong Kong  
▪ **M.Phil. in Mathematics** 2014–2016  
• Advisor: [Ronald Lok Ming Lui](#)  
• Thesis: “[Surface Conformal/Quasi-conformal Parameterization with Applications](#)”  
(with 2017 New World Mathematics Award, Silver Medal for Master Thesis)  
▪ **B.Sc. in Mathematics** (First Class Honors) 2010–2014  
• Streams: Enrichment Stream in Mathematics, Computational and Applied Mathematics Stream  
• Minors: Computer Science, Earth System Science

## RESEARCH INTERESTS

Applied and Computational Geometry, Interdisciplinary Mathematical Modeling, Mechanical Metamaterials, Quantitative Biology, Medical Imaging, Geometry Processing, Scientific Computing

## PUBLICATIONS PREPRINT/SUBMITTED

- [42] [G. P. T. Choi](#), L. Liu, L. Mahadevan, “[Explosive rigidity percolation in kirigami](#),” submitted, arXiv:2211.15073.
- [41] Y. Guo, Q. Chen, [G. P. T. Choi](#), L. M. Lui, “[Automatic landmark detection and registration of brain cortical surfaces via quasi-conformal geometry and convolutional neural networks](#),” submitted, arXiv:2208.07010.
- [40] L. Dudte,\* [G. P. T. Choi](#),\* K. P. Becker, L. Mahadevan, “[An additive framework for kirigami design](#),” submitted, arXiv:2207.01810. (\*equal contribution)

## ACCEPTED/PUBLISHED

- [39] T. Dixit, [G. P. T. Choi](#),\* S. Al-Mosleh,\* J. Lund, J. Troscianko, C. Moya, L. Mahadevan, C. N. Spottiswoode, “Combined measures of mimetic fidelity explain imperfect mimicry in a brood parasite-host system,” *Biology Letters*, to appear. (\*equal contribution)
- [38] R. Supekar, B. Song, A. Hastewell, [G. P. T. Choi](#), A. Mietke, J. Dunkel, “[Learning hydrodynamic equations for active matter from particle simulations and experiments](#),” *Proceedings of the National Academy of Sciences*, to appear.
- [37] Z. Zhu, [G. P. T. Choi](#), L. M. Lui, “[Parallelizable global quasi-conformal parameterization of multiply connected surfaces via partial welding](#),” *SIAM Journal on Imaging Sciences*, 15(4), 1765–1807 (2022).
- [36] L. Liu,\* [G. P. T. Choi](#),\* L. Mahadevan, “[Quasicrystal kirigami](#),” *Physical Review Research*, 4(3), 033114 (2022). (\*equal contribution)  
• Selected as Editors’ Suggestion.

- [35] S. Chen, F. Giardina, G. P. T. Choi, L. Mahadevan, “Modular representation and control of floppy networks,” *Proceedings of the Royal Society A*, 478(2264), 20220082 (2022).
- [34] G. P. T. Choi,<sup>†</sup> A. Giri, L. Kumar, “Adaptive area-preserving parameterization of open and closed anatomical surfaces,” *Computers in Biology and Medicine*, 148, 105715 (2022). (<sup>†</sup>corresponding author)
- [33] G. P. T. Choi, L. M. Lui, “Recent developments of surface parameterization methods using quasi-conformal geometry,” *Handbook of Mathematical Models and Algorithms in Computer Vision and Imaging*, Springer Nature Switzerland AG (2022).
- [32] D. Zhang, G. P. T. Choi, J. Zhang, L. M. Lui, “A unifying framework for  $n$ -dimensional quasi-conformal mappings,” *SIAM Journal on Imaging Sciences*, 15(2), 960–988 (2022).
- [31] H. Law, G. P. T. Choi, K. C. Lam, L. M. Lui, “Quasiconformal model with CNN features for large deformation image registration,” *Inverse Problems and Imaging*, 16(4), 1019–1046 (2022).
- [30] G. P. T. Choi, Y. Liu, L. M. Lui, “Free-boundary conformal parameterization of point clouds,” *Journal of Scientific Computing*, 90(1), 14 (2022).
- [29] S. Al-Mosleh, G. P. T. Choi, A. Abzhanov, L. Mahadevan, “Geometry and dynamics link form, function and evolution of finch beaks,” *Proceedings of the National Academy of Sciences*, 118(46), e2105957118 (2021).  
• Featured in [Harvard SEAS News](#).
- [28] G. P. T. Choi, L. H. Dudte, L. Mahadevan, “Compact reconfigurable kirigami,” *Physical Review Research*, 3(4), 043030 (2021).
- [27] M. Shaqfa, G. P. T. Choi, K. Beyer, “Spherical cap harmonic analysis (SCHA) for characterising the morphology of rough surface patches,” *Powder Technology*, 393, 837–856 (2021).
- [26] L. Liu,\* G. P. T. Choi,\* L. Mahadevan, “Wallpaper group kirigami,” *Proceedings of the Royal Society A*, 477(2252), 20210161 (2021). (\*equal contribution)
- [25] B. Jarvis, G. P. T. Choi, B. Hockman, B. Morrell, S. Bandopadhyay, D. Lubey, J. Villa, S. Bhaskaran, D. Bayard, I. A. Nesnas, “3D shape reconstruction of small bodies from sparse features,” *IEEE Robotics and Automation Letters*, 6(4), 7089–7096 (2021).
- [24] M. B. Edwards, G. P. T. Choi, N. J. Derieg, Y. Min, A. C. Diana, S. A. Hodges, L. Mahadevan, E. M. Kramer, E. S. Ballerini, “Genetic architecture of floral traits in bee- and hummingbird-pollinated sister species of *Aquilegia* (columbine),” *Evolution*, 75(9), 2197–2216 (2021).
- [23] L. H. Dudte, G. P. T. Choi, L. Mahadevan, “An additive algorithm for origami design,” *Proceedings of the National Academy of Sciences*, 118(21), e2019241118 (2021).
- [22] G. P. T. Choi, “Efficient conformal parameterization of multiply-connected surfaces using quasi-conformal theory,” *Journal of Scientific Computing*, 87(3), 70 (2021).
- [21] G. P. T. Choi,<sup>†</sup> C. H. Rycroft, “Volumetric density-equalizing reference map with applications,” *Journal of Scientific Computing*, 86(3), 41 (2021). (<sup>†</sup>corresponding author)
- [20] A. Giri,\* G. P. T. Choi,\*<sup>†</sup> L. Kumar, “Open and closed anatomical surface description via hemispherical area-preserving map,” *Signal Processing*, 180, 107867 (2021). (\*equal contribution) (<sup>†</sup>corresponding author)
- [19] G. P. T. Choi, S. Chen, L. Mahadevan, “Control of connectivity and rigidity in prismatic assemblies,” *Proceedings of the Royal Society A*, 476(2244), 20200485 (2020).
- [18] G. P. T. Choi, D. Qiu, L. M. Lui, “Shape analysis via inconsistent surface registration,” *Proceedings of the Royal Society A*, 476(2242), 20200147 (2020).
- [17] A. Chakrabarti, G. P. T. Choi, L. Mahadevan, “Self-excited motions of volatile drops on swellable sheets,” *Physical Review Letters*, 124(25), 258002 (2020).  
• Featured in media outlets including [Harvard SEAS News](#), [Phys.org](#), [Tech Explorist](#), and [N+1](#) (in Russian).
- [16] G. P. T. Choi, Y. Leung-Liu, X. Gu, L. M. Lui, “Parallelizable global conformal parameterization of simply-connected surfaces via partial welding,” *SIAM Journal on Imaging Sciences*, 13(3), 1049–1083 (2020).
- [15] S. Chen,\* G. P. T. Choi,\* L. Mahadevan, “Deterministic and stochastic control of kirigami topology,” *Proceedings of the National Academy of Sciences*, 117(9), 4511–4517 (2020). (\*equal contribution)

- [14] G. P. T. Choi,<sup>†</sup> B. Chiu, C. H. Rycroft, “Area-preserving mapping of 3D carotid ultrasound images using density-equalizing reference map,” *IEEE Transactions on Biomedical Engineering*, 67(9), 1507–1517 (2020). (<sup>†</sup>corresponding author)
- [13] G. P. T. Choi, H. L. Chan, R. Yong, S. Ranjitkar, A. Brook, G. Townsend, K. Chen, L. M. Lui, “Tooth morphometry using quasi-conformal theory,” *Pattern Recognition*, 99, 107064 (2020).
- [12] A. Pumarola, J. Sanchez-Riera, G. P. T. Choi, A. Sanfeliu, F. Moreno-Noguer, “3DPeople: Modeling the geometry of dressed humans,” *Proceedings of the IEEE International Conference on Computer Vision (ICCV)*, 2242–2251 (2019).  
 • Featured in media outlets including *AI<sup>3</sup> | Theory, Practice, Business* and *Synced*.
- [11] G. P. T. Choi, L. H. Dudte, L. Mahadevan, “Programming shape using kirigami tessellations,” *Nature Materials*, 18, 999–1004 (2019).  
 • Featured on the cover and in media outlets including *Harvard SEAS News*, *Science Daily*, *Interesting Engineering*, *Phys.org*, *Index Hungary (in Hungarian)*, *fabcross (in Japanese)*, *Asahi Shimbun (in Japanese)*, and *Popular Mechanics*.
- [10] G. P. T. Choi, L. Mahadevan, “Planar morphometrics using Teichmüller maps,” *Proceedings of the Royal Society A*, 474(2217), 20170905 (2018).
- [9] C. P. Yung, G. P. T. Choi, K. Chen, L. M. Lui, “Efficient feature-based image registration by mapping sparsified surfaces,” *Journal of Visual Communication and Image Representation*, 55, 561–571 (2018).
- [8] G. P. T. Choi,<sup>†</sup> C. H. Rycroft, “Density-equalizing maps for simply connected open surfaces,” *SIAM Journal on Imaging Sciences*, 11(2), 1134–1178 (2018). (<sup>†</sup>corresponding author)
- [7] G. P. T. Choi, L. M. Lui, “A linear formulation for disk conformal parameterization of simply-connected open surfaces,” *Advances in Computational Mathematics*, 44(1), 87–114 (2018).
- [6] G. P. T. Choi, Y. Chen, L. M. Lui, B. Chiu, “Conformal mapping of carotid vessel wall and plaque thickness measured from 3D ultrasound images,” *Medical & Biological Engineering & Computing*, 55(12), 2183–2195 (2017).
- [5] G. P. T. Choi, M. H. Y. Man, L. M. Lui, “Fast spherical quasiconformal parameterization of genus-0 closed surfaces with application to adaptive remeshing,” *Geometry, Imaging and Computing*, 3(1–2), 1–29 (2016).
- [4] T. W. Meng, G. P. T. Choi, L. M. Lui, “TEMPO: Feature-endowed Teichmüller extremal mappings of point clouds,” *SIAM Journal on Imaging Sciences*, 9(4), 1922–1962 (2016).
- [3] G. P. T. Choi, K. T. Ho, L. M. Lui, “Spherical conformal parameterization of genus-0 point clouds for meshing,” *SIAM Journal on Imaging Sciences*, 9(4), 1582–1618 (2016).
- [2] P. T. Choi, L. M. Lui, “Fast disk conformal parameterization of simply-connected open surfaces,” *Journal of Scientific Computing*, 65(3), 1065–1090 (2015).
- [1] P. T. Choi, K. C. Lam, L. M. Lui, “FLASH: Fast landmark aligned spherical harmonic parameterization for genus-0 closed brain surfaces,” *SIAM Journal on Imaging Sciences*, 8(1), 67–94 (2015).

## RESEARCH FUNDING

- (Co-I) Hong Kong Research Grants Council (14307622) 2023–2025
  - Title: *A New Framework for Imaging with Shape Priors Using Harmonic Beltrami Signature*
  - Amount: HK\$783,000
- (PI) NSF Mathematical Sciences Postdoctoral Research Fellowship (DMS-2002103) 2020–2023
  - Title: *Interplay between Geometry, Topology, and Physics in Science and Engineering*
  - Amount: US\$150,000

## AWARDS AND HONORS

- SIAM Early Career Travel Award 2022
- NSF Mathematical Sciences Postdoctoral Research Fellowship 2020–2023
  - About 40 awardees nationally per year.
- SIAM Student Travel Award 2020
- NSF-Simons QuantBio Student Fellowship, Harvard University 2019–2020
- Silver Medal for Master Thesis, New World Mathematics Award 2017
- Best Poster Award, Workshop on Applications-Driven Geometric Functional Data Analysis 2017
- Certificate of Distinction in Teaching, Harvard University 2017
- Croucher Foundation Scholarship, Croucher Foundation 2016–2019

- About 10 awardees per year for doctoral study in natural sciences, medicine or technology.
- Hong Kong Scholarship for Excellence, HKSAR Government 2016
- Mr. Ch'ien Mu Postgraduate Scholarship, New Asia College, CUHK 2016
- Best Teaching Assistant Award, Department of Mathematics, CUHK 2014–2015

- PRESENTATIONS**
- Geometry and Packing in Materials Science and Biology (GeomPack) (Virtual) Dec 2022
    - Geometric design of kirigami metamaterials
  - New England Workshop on the Mechanics of Materials and Structures (NEW.Mech 2022), Cambridge, MA, USA May 2022
    - Additive kirigami
  - SIAM Conference on Imaging Science (SIAM-IS22) (Virtual) Mar 2022
    - Geometric design of kirigami metamaterials
  - APS March Meeting 2022, Chicago, IL, USA Mar 2022
    - Additive design of origami and kirigami
  - APS March Meeting 2021 (Virtual) Mar 2021
    - Reconfigurable kirigami
  - SIAM Conference on Imaging Science (SIAM-IS20) (Virtual) Jul 2020
    - Quantifying shape variation using quasi-conformal geometry
  - The 8th Annual Winter Q-Bio Conference (2020 Winter Q-Bio), Waikoloa Village, HI, USA Feb 2020
    - Planar morphometrics via Teichmüller mappings
  - MIT Physical Mathematics Seminar, Cambridge, MA, USA Dec 2019
    - Geometric and topological control of kirigami
  - New England Workshop on the Mechanics of Materials and Structures (NEW.Mech 2019), Amherst, MA, USA Oct 2019
    - Geometric and topological control of kirigami
  - APS March Meeting 2019, Boston, MA, USA Mar 2019
    - Inverse kirigami design
  - SIAM Conference on Computational Science and Engineering (SIAM-CSE19), Spokane, WA, USA Feb 2019
    - Density-equalizing reference map with applications
  - International Conference on Applied Mathematics (ICAM) 2018, Hong Kong Jun 2018
    - Density-equalizing maps for simply-connected open surfaces
  - New England Workshop on the Mechanics of Materials and Structures (NEW.Mech 2017), Cambridge, MA, USA Oct 2017
    - Programming shape using kirigami tessellations
  - Workshop on Applications-Driven Geometric Functional Data Analysis, Tallahassee, FL, USA Oct 2017
    - Planar morphometrics via Teichmüller mappings (with the Best Poster Paper Award)
  - The Third International Conference on Engineering and Computational Mathematics (ECM2017), Hong Kong Jun 2017
    - Planar morphometrics via Teichmüller mappings
  - Croucher Symposium 2016, Hong Kong Dec 2016
    - Geometric problems in biology
  - International Conference on Applied Mathematics (ICAM) 2016, Hong Kong Jun 2016
    - Spherical conformal parameterization of genus-0 point clouds for meshing
  - The Hong Kong Mathematical Society Annual General Meeting 2016, Hong Kong May 2016
    - Spherical conformal parameterization of genus-0 point clouds for meshing
  - The Hong Kong Mathematical Society Annual General Meeting 2015, Hong Kong May 2015
    - Fast Disk conformal parameterization of simply-connected open surfaces
  - International Conference on Applied Mathematics (ICAM) 2014, Hong Kong Dec 2014
    - FLASH: Fast landmark aligned spherical harmonic parameterization for genus-0 closed brain surfaces
  - 2014 Imaging Science Camp, Guangzhou, China Nov 2014
    - FLASH: Fast landmark aligned spherical harmonic parameterization for genus-0 closed brain surfaces
  - SIAM Conference on Imaging Science (SIAM-IS14), Hong Kong May 2014
    - Fast optimized harmonic registration of genus-0 closed surfaces with landmark constraints

**TEACHING**

**Massachusetts Institute of Technology, USA**

- **Instructor in Applied Mathematics**, Department of Mathematics 2021–Present
  - (Course Administrator) 18.03 Differential Equations, Spring 2023.
  - (Lecturer) 18.085/18.0851 Computational Science and Engineering, Fall 2022. (Student evaluation = 6.2/7.0)
  - (Guest Lecturer) 18.04 Complex Variables with Applications, Spring 2022.

- (Recitation Instructor) 18.06 Linear Algebra, Spring 2022. (Student evaluation = 6.6/7.0)
- (Recitation Instructor) 18.03 Differential Equations, Fall 2021. (Student evaluation = 6.2/7.0)

#### Harvard University, USA

- **Teaching Fellow**, John A. Paulson School of Engineering and Applied Sciences (SEAS) 2017
  - AM205 Advanced Scientific Computing: Numerical Methods, Fall 2017.
  - (with *Certificate of Distinction in Teaching*; Student evaluation = 4.71/5.00, SEAS average = 4.29/5.00)

#### The Chinese University of Hong Kong, Hong Kong

- **Teaching Assistant**, Department of Mathematics 2014–2016
  - MATH3220 Operations Research and Logistics, Spring 2016.
  - MATH3080 Number Theory, Fall 2015.
  - MATH3220 Operations Research and Logistics, Spring 2015. (with *2014–15 Best Teaching Assistant Award*)
  - MATH3080 Number Theory, Fall 2014. (with *2014–15 Best Teaching Assistant Award*)
- **Teaching Assistant Leader**, EPYMT 2012–2015
 

The Enrichment Programme for Young Mathematics Talents (EPYMT) is an enrichment programme offered by the Department of Mathematics for mathematically gifted secondary school students.

  - SAYT1134 Towards Differential Geometry, Summer 2015.
  - SAYT1134 Towards Differential Geometry, Summer 2014.
  - SAYT1114 Number Theory and Cryptography, Summer 2012.
- **Assistant Mentor**, EPYMT 2011–2013
  - CUSA0114 Enrichment Mentoring Mathematics II, November 2012 – July 2013.
  - CUSA0104 Enrichment Mentoring Mathematics I, October 2012 – July 2013.
  - CUSA0114 Enrichment Mentoring Mathematics II, October 2011 – June 2012.
- **Teaching Assistant**, EPYMT 2011–2012
  - SAYT1134 Towards Differential Geometry, Summer 2012.
  - SAYT1154 Mathematical Analysis: An Overture I, Spring 2012.
  - SAYT1114 Number Theory and Cryptography, Summer 2011.
  - CUSA1014 Geometric Perspectives of Complex Numbers, Summer 2011.

#### STUDENT MENTORING

##### UNDERGRADUATE STUDENTS

- Lucy Liu (Harvard College) 2019–2022
  - Senior thesis: “Beyond Grid Kirigami”
  - Publications: Proc. R. Soc. A (2020), Phys. Rev. Research (2022)

##### HIGH SCHOOL STUDENTS

- Hiu-Long Chan and Bock-Man Cheung (Baptist Lui Ming Choi Secondary School, HK) 2022
  - Research project: “On the Coprime Product Series and Its Divergence and Bounds”
  - Award: Gold Award in Mathematics, 2022 S.T. Yau High School Science Award (Asia)

#### PROFESSIONAL ACTIVITIES

- Internal Service, MIT Mathematics 2022–Present
  - Undergraduate Academic Advisor
  - Graduate Student Teaching Mentor
- Conference Organization 2021–Present
  - Co-organizer, Minisymposium on “Geometry, Computing and Learning for Science and Engineering”, SIAM Conference on Imaging Science (SIAM-IS) 2022
- Referee Service 2015–Present
  - Journal reviewer
    - Nature Communications; PLOS Computational Biology; Communications Physics; Communications Materials; Extreme Mechanics Letters; Meccanica; IEEE Transactions on Medical Imaging; IEEE Transactions on Visualization and Computer Graphics; SIAM Journal on Imaging Sciences; Journal of Scientific Computing; Journal of Mathematical Imaging and Vision; Computational Geometry: Theory and Applications; Geometry, Imaging and Computing; Mathematics, Computation and Geometry of Data; Current Medical Imaging Reviews; Mathematical Reviews
  - Proposal reviewer
    - Dutch Research Council

#### OUTREACH ACTIVITIES

- **Invited Speaker**, Baptist Lui Ming Choi Secondary School, Hong Kong (Virtual) 2021
  - Topic: Origami and kirigami: art, mathematics, science and technology
- **Invited Speaker**, Baptist Lui Ming Choi Secondary School, Hong Kong (Virtual) 2020
  - Topic: On mathematics study and research
- **ICED Epic Innovation Session Presenter**, Innovative Conceptual Engineering Design Program, Nipmuc Regional High School, USA 2019
  - Gave a talk about designing shape-shifting structures using kirigami to high school students, teachers, and community members in Massachusetts for promoting science, technology and innovation.

- **Hang Lung Fun Math Tutorial Class Volunteer**, Hang Lung As One Volunteer Team and Department of Mathematics, CUHK, Hong Kong 2016
  - Provided free mathematics tutoring service to underprivileged primary school students and organized mathematics-related games to arouse their interest in mathematics.
- **Mathematics Teacher Volunteer**, Hang Lung As One Volunteer Team and Department of Mathematics, CUHK, Hong Kong 2015
  - Provided free mathematics tutoring service to underprivileged primary school students.

## SOFTWARE

### METAMATERIALS

- Additive Kirigami 2022  
<https://github.com/garyptchoi/additive-kirigami>
- 2D Kirigami Deployment Simulator 2021  
[https://github.com/liliu12/kirigami\\_sim](https://github.com/liliu12/kirigami_sim)
- Inverse Kirigami Design 2019  
<https://github.com/garyptchoi/inverse-kirigami-design>

### SURFACE PARAMETERIZATION AND HARMONICS

- Spherical Cap Harmonics 2021  
<https://github.com/eesd-epfl/spherical-cap-harmonics>
- Poly-Annulus Conformal Map 2021  
<https://github.com/garyptchoi/poly-annulus-conformal-map>
- Rectangular Conformal Map 2016  
<https://www.mathworks.com/matlabcentral/fileexchange/67117-rectangular-conformal-map>
- Disk Conformal Map 2015  
<https://www.mathworks.com/matlabcentral/fileexchange/65571-disk-conformal-map>
- Spherical Conformal Map 2015  
<https://www.mathworks.com/matlabcentral/fileexchange/65551-spherical-conformal-map>

### IMAGE PROCESSING

- TRIM: Triangulating Image 2018  
<https://www.mathworks.com/matlabcentral/fileexchange/68629-trim-triangulating-image>

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