Alexander D. Kaiser

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Education

PhD Mathematics, thesis: Modeling the Mitral Valve 2017
New York University, Courant Institute of Mathematical Sciences

MS Mathematics, thesis: Computational Experiments in Markov Chain Monte Carlo 2013
New York University, Courant Institute of Mathematical Sciences

BA Mathematics; minor, Computer Science 2009
University of California, Berkeley

Grants

- **K25 Mentored Quantitative Research Development Award** 2024
  National Heart Lung and Blood Institute, National Institutes of Health (NIH)
  $908,880, 5 years, 2024 – 2029
- **American Heart Association Career Development Award (AHA CDA)** 2024
  $231,000, 3 years, 2024 – 2027
- **Stanford Maternal & Child Health Research Institute Instructor K Award Support** 2025
  $100,000, 2 years, 2025 – 2027

Awards and Fellowships

- Kurt O. Friedrichs Prize for Outstanding Dissertation in Mathematics 2018
  PhD thesis award, Dept. of Mathematics, New York University
- Math Master's Thesis Prize 2014
  MS thesis award, Dept. of Mathematics, New York University
- Mechanisms and Innovation in Cardiovascular Disease T32 Training Fellowship, 2018
  National Heart Lung and Blood Institute, National Institutes of Health (NIH)
- Stanford-Arizona-Morehouse-UAB Cardiovascular Research Symposium Poster Award 2024
- NSF (National Science Foundation) Graduate Research Fellowship 2013
- Benchmark Capital Fellowship in Congenital Cardiovascular Bioengineering 2020
- Thomas Tyler Bringley Fellowship, Dept. of Mathematics, New York University 2016
- Henry M. MacCracken Fellowship, New York University 2013

Experience

Stanford University
Instructor, Cardiothoracic Surgery 2024 –
Research Engineer, Pediatrics (Cardiology) 2022 – 2024
Postdoctoral Scholar, Pediatrics (Cardiology) & Inst Comp and Math Engineering 2017 – 2022

- Research in computational cardiac mechanics, focused on mechanics of the aortic valve.
- Developed simulation-guided design tools for cardiac surgical repairs of congenitally diseased valves.
- Studied flow in congenital valvular heart disease and produced evidence of cause of aneurysms.
- Performed direct comparisons of immersed boundary method simulation data against in vitro MRI data to demonstrate realism of methods.

New York University, Courant Institute of Mathematical Sciences
Doctoral & Master's Student Researcher, Department of Mathematics 2011 – 2017

- Research on modeling and simulation of cardiac fluid flow and mechanics.
- Developed novel first-principles modeling methodologies called elasticity-based design for the mitral valve.
- Performed fluid-structure interaction simulations of the mitral valve, which showed new realism and robustness over multiple cardiac cycles.
- Research on Markov chain Monte Carlo (MCMC) methods for parameter estimation in differential equations. Developed, implemented and tested parallelization algorithms of MCMC methods using graphics processing units (GPUs).

Innovein Medical, Consultant 2018 – 2019

- Developed simulation-based design tools for a prosthetic vein valve medical device.

Lawrence Berkeley National Laboratory
Computer Systems Engineer, Complex Systems & Future Technologies Groups 2009 – 2011

- Conducted numerical analysis and parallel computing research.
- Developed and maintained arbitrary- and extended-precision open-source software packages, ARPREC and QD.

University of Newcastle
Visiting Researcher, Centre for Computer Assisted Research and Applications 2011

- Research on symbolic simplification. Designed and implemented algorithms for automated simplification of constants of the form $\sum_{i=1}^{n} \alpha_i z_i$ with α_i rational, z_i complex and n large.
- Achieved over 1000x speedup compared to built-in algorithms in *Mathematica* on certain problems.

Apple Inc.
Cooperative Researcher, Advanced Computation Group 2010

- Developed mixed language interface for MatrixFFT, Apple's high-performance library for Fast Fourier Transforms.

Jet Propulsion Laboratory, NASA
Summer Student Researcher, Information Processing Group 2007

- Generated and evaluated performance data for error correcting codes developed for the NASA Deep Space Network communication standard.
- Designed, implemented and validated robust schemes to eliminate false positives in error detection.

Publications

Selected highlight publications:

1. **Kaiser AD**, Haidar MA, Choi PS, Sharir A, Marsden AL, Ma MR. Simulation-Based Design of Bicuspidization of the Aortic Valve. *The Journal of Thoracic and Cardiovascular Surgery*, 2024. arxiv doi
2. **Kaiser AD**, Shad R, Schiavone N, Hiesinger W, Marsden AL. Controlled Comparison of Simulated Hemodynamics across Tricuspid and Bicuspid Aortic Valves. *Annals of Biomedical Engineering*, 2022. arxiv doi
3. **Kaiser AD**, McQueen DM, Peskin CS. Modeling the Mitral Valve. *International Journal of Numerical Methods in Biomedical Engineering*, 2019. arxiv doi

Journal publications:

4. **Kaiser AD**, Choi PS, Sharir A, Marsden AL, Ma MR. Simulation-Guided Design of Leaflet Height in Bicuspidization of the Aortic Valve. *JTCVS Open*, 2025. *(accepted, in press.)* doi

5. **Kaiser AD**, Wang J, Brown AL, Zhu E, Hsiai T, Marsden AL. A Fluid-Structure Interaction Model of the Zebrafish Aortic Valve. *Journal of Biomechanics*, 2025. arxiv doi
6. Choi PS, Sharir A, Ono Y, Shibata M, **Kaiser AD**, Palagani Y, Marsden AL, Ma MR Combined Simulation and Ex-vivo Assessment of Free-edge Length in Bicuspidization Repair for Congenital Aortic Valve Disease, *JTCVS Open*, 2024. doi
7. Choi PS, Sharir A, Ono Y, Shibata M, **Kaiser AD**, Zhu Y, Marsden AL, Woo YJ, Ma MR, Kim JB. Effect of Graft Sizing in Valve-sparing Aortic Root Replacement for Bicuspid Aortic Valve: The Goldilocks Ratio. *The Journal of Thoracic and Cardiovascular Surgery Techniques*, 2024. doi
8. **Kaiser AD***, Schiavone NK*, Elkins CJ, McElhinney DB, Eaton JK, Marsden AL. Comparison of Immersed Boundary Simulations of Heart Valve Hemodynamics against In Vitro 4D Flow MRI Data. (*contributed equally) *Annals of Biomedical Engineering*, 2023. arxiv doi
9. Frishman S, Kight A, Pirozzi I, Maddineni S, Imbrie-Moore A, Karachiwalla Z, Paulsen MJ, **Kaiser AD**, Woo YJ, Cutkosky MR. DynaRing: a Patient Specific Mitral Annuloplasty Ring with Selective Stiffness Segments. *Journal of Medical Devices*, 2022. doi
10. **Kaiser AD**, Shad R, Hiesinger W, Marsden AL. A Design-Based Model of the Aortic Valve for Fluid-Structure Interaction. *Biomechanics and Modeling in Mechanobiology*, 2021. arxiv doi
11. Shad R, **Kaiser AD**, Kong S, Fong R, Quach N, Bowles C, Kasinpila P, Shudo Y, Teuteberg J, Woo YJ, Marsden AL, Hiesinger W. Patient Specific Computational Fluid Dynamics Reveal Localized Flow Patterns Predictive of Post-LVAD Aortic Incompetence *Circulation: Heart Failure*, 2021. doi
12. Kasinpila P, Kong S, Fong R, Shad R, **Kaiser AD**, Marsden AL, Woo YJ, Hiesinger W. Use of Patient-Specific Computational Models for Optimization of Aortic Insufficiency after Implantation of Left Ventricular Assist Device. *The Journal of Thoracic and Cardiovascular Surgery*, 2020. doi
13. Bailey DH, Borwein JM, **Kaiser AD**. Automated Simplification of Large Symbolic Expressions. *Journal of Symbolic Computation*, 2014. doi

Conference proceedings (peer reviewed):

14. **Kaiser AD**, Williams S, Madduri K, Ibrahim K, Bailey DH, Demmel JW, Strohmaier E. A Principled Kernel Testbed for Hardware/Software Co-Design Research. *Proceedings of USENIX Workshop on Hot Topics in Parallelism*, 2010. pdf
15. **Kaiser AD**, Dolinar S, Cheng MK, Undetected Errors in Quasi-cyclic LDPC Codes Caused by Receiver Symbol Slips. *Proceedings of IEEE Global Conference on Communications*, 2009. doi

Submitted for review

1. Choi PS,* **Kaiser AD***, Nilkant R, Sharir A, Marsden AL, Ma MR. From Model to Patient: Early Incorporation of Computationally-Derived Principles of Free-edge Length in Bicuspidization Repair. (*contributed equally) *Submitted*. 2025

Preprints & Technical Reports

1. Bao Y, **Kaiser AD**, Kaye J, Peskin CS. Gaussian-Like Immersed Boundary Kernels with Three Continuous Derivatives and Improved Translational Invariance. *Preprint*, 2017. arXiv
2. **Kaiser AD**, Williams S, Madduri K, Ibrahim K, Bailey DH, Demmel JW, Strohmaier E. TORCH – Computational Reference Kernels: A Testbed for Computer Science Research. *LBNL Technical Report*, 2010. pdf

Conference Abstracts

1. **Kaiser AD**, Choi P, Sharir A, Marsden AL, Ma M. Simulation-Guided Design of Leaflet Height in Bicuspidization of the Aortic Valve. *American Association for Thoracic Surgery 105th Annual Meeting*, 2025. pdf

2. Choi P, Sharir A, Nilkant R, **Kaiser AD**, Ma M. Biomechanical Assessment of No-cut Tricuspidization vs Bicuspidization Repairs in Quadricuspid Truncal Valve Model *American Association for Thoracic Surgery 105th Annual Meeting*, 2025. pdf
3. Choi P, Sharir A, Shibata M, **Kaiser AD**, Zhu Y, Marsden AL, Woo YJ, Ma M, Kim JB. Effect of Graft Sizing in Valve-sparing Aortic Root Replacement for Bicuspid Aortic Valve: The Goldilocks Ratio. *American Association for Thoracic Surgery Aortic Symposium*, 2024. pdf
4. Haidar M, Choi P, **Kaiser AD**, Sharir A, Kapula N, Shibata M, Marsden AL, Ma MR A Novel Approach for Aortic Valve Bicuspidization: Integrating Computational and Ex-vivo Simulation Concepts of Free-edge Leaflet Length in a modified Schäfer's procedure. *American Association for Thoracic Surgery 104th Annual Meeting*, 2024. pdf
5. **Kaiser AD**, Shad R, Schiavone N, Hiesinger W, Marsden AL. Fluid-Structure Interaction Simulations of Bicuspid Aortic Valve Disease. *Circulation 144 (Suppl_ 1)*, A13417, 2021. doi
6. **Kaiser AD**, Marsden AL. Modeling Patient-Specific Left-Ventricular Blood Flow and Mitral Valve Dynamics. *Proceedings of 6th International Conference on Computational and Mathematical Biomedical Engineering (CMBE)*, (extended conference abstract) 2019. pdf
7. Strohmaier E, Williams S, **Kaiser AD**, Madduri K, Ibrahim J, Bailey DH, Demmel JW. A Kernel Testbed for Parallel Architecture, Language and Performance Research. *Proceedings of the International Conference on Numerical Analysis and Applied Mathematics*, 2010. doi

Invited Seminars

1. "Designing heart valves from first principles: model generation, congenital disease & surgical treatment," MEAM Seminar, Department of Mechanical Engineering and Applied Mechanics, University of Pennsylvania, Philadelphia PA, 2024
2. "Multimodal optimization of congenital aortic valve repair," joint with Perry Choi, Biomechanics Seminar, Stanford University, Stanford CA, 2024
3. "Designing heart valves from first principles: model generation, congenital disease & surgical treatment," HEART Lab Seminar, Division of Cardiovascular Medicine, Department of Medicine, Stanford University, Stanford CA, 2024
4. "Design-Based Models of Heart Valves for Fluid-Structure Interaction," Fluid Mechanics Seminar, Department of Mechanical Engineering, Stanford University, Stanford CA, 2022
5. "Design-Based Models of Heart Valves for Fluid-Structure Interaction," Computational Medicine Department Seminar, UCLA, Los Angeles CA, 2022
6. "Design-Based Models of Heart Valves for Fluid-Structure Interaction," Biomechanics and Medical Devices Seminar, Department of Mechanical Engineering, UC San Diego, San Diego CA (virtual), 2022
7. "Design-Based Models of Heart Valves for Fluid-Structure Interaction," Department of Mathematics Seminar, UC Riverside, Riverside CA, 2022
8. "Design-Based Models of Heart Valves for Fluid-Structure Interaction," ReCoVor: Remote Colloquium on Vortex Flows, virtual, 2021
9. "Modeling the Mitral Valve," CME 300: First Year Seminar Series, Institute for Computational & Mathematical Engineering, Stanford University, Stanford CA, 2018
10. "Modeling the Mitral Valve," Computational Biology Colloquium, Courant Institute of Mathematical Sciences, New York University, New York NY, 2016
11. "Computational Experiments in Markov Chain Monte Carlo," Student Numerical Analysis and Scientific Computing Seminar, Courant Institute of Mathematical Sciences, New York University, New York NY, 2016
12. "Automated Simplification of Large Symbolic Expressions," Centre for Computer Assisted Research and Applications Seminar, University of Newcastle, Newcastle NSW Australia, 2011

13. "A Testbed Based on the Motifs of Parallel Computing," Computational Research Division Seminar, Lawrence Berkeley National Laboratory, Berkeley CA, 2010

Mentoring

- **Karoline-Marie Bornemann, PhD**, Postdoctoral Scholar, Stanford University 2025 –
  Primary postdoctoral mentoring. Hired and fully funded under grants to ADK.
  Fluid-structure interaction modeling of neonates with rare congenital heart disease.
- **Elena Martinez, MS**, PhD student, Stanford University 2025 –
  Image-based modeling of complex congenital ventricular repair.
- **Perry Choi, MD**, Resident, Cardiothoracic Surgery, Stanford University 2024 –
  Collaborator and research support on funded internal postdoctoral fellowship.
- **Han Zhao, PhD**, Postdoctoral Scholar, Stanford University 2025 –
  Comparison of fluid-structure interaction methods for valve simulations.
- **Gabriel Weininger, MD**, Resident, Cardiothoracic Surgery, Stanford University 2025 –
  Collaborator on NIH postdoctoral fellowship application on prosthetic valve design.
- **Jon Hochstein, MD**, Resident, Cardiothoracic Surgery, Stanford University 2025 –
  Collaborator on NIH postdoctoral fellowship application on Fontan flow mechanics.
- **Nicole Schiavone, MS**, PhD student, Stanford University 2020 – 2021
  Experimental validation and flow analysis in immersed boundary methods.
- **Gerald Kang**, Undergraduate, Stanford University 2021
  Shear stress properties in CFD.
- **Sandra Kong**, Undergraduate, Stanford University 2018
  Modeling of vascular system and flows in medical devices.

Teaching Experience

- Guest Lecture, "Designing heart valves from first principles: model generation, congenital disease & surgical treatment," 2025
  MED 223: Cardiovascular and Pulmonary Sciences Seminar, Stanford University
- Guest Lecture, "Designing heart valves from first principles: model generation, congenital disease & surgical treatment," Mechanical and Aerospace Engineering 261: Cardiovascular Fluid Mechanics, University of California, San Diego 2025
- Guest Lecture, "Designing heart valves from first principles: model generation, congenital disease & surgical treatment," Mechanical and Aerospace Engineering 261: Cardiovascular Fluid Mechanics, University of California, San Diego 2024
- Guest lecture, "Newton's method for numerical solution of nonlinear ordinary differential equations," Computational and Mathematical Engineering 209: Mathematical Modeling of Biological Systems, Stanford University 2022
- Guest lecture, "Modeling heart valves," BIOE 285: Computational Modeling in the Cardiovascular System, Stanford University 2019
- Guest lecture, "A design-based model of the mitral valve & simulations of patient-specific left-ventricular flow," MED 289: Introduction to Bioengineering Research, Stanford University 2019
- Teaching assistant, Introduction to Mathematical Analysis I (graduate level) 2015
- Teaching assistant, Analysis (undergraduate level) 2015

Professional Service

- **Journal peer review:** 2017 –
  - Journal of Computational Physics
  - Physics of Fluids

  - Biomechanics and Modeling in Mechanobiology
  - Cardiovascular Engineering and Technology (CVET)
  - International Journal for Numerical Methods in Biomedical Engineering
  - Journal of Biomechanical Engineering
  - Computers in Biology and Medicine
  - Journal of Mechanics in Medicine and Biology
  - Computer Graphics Forum
  - Scientific Reports
- **Trainee Committee:** Intl. Conf. on Functional Imaging and Modeling of the Heart (FIMH-2021) 2021
- **Grant review:** Stanford Cardiovascular Institute Seed Grant Competition 2020
- **Session Chair:** Fluid Dynamics I, SIAM Life Sciences, (cancelled due to covid) 2020
- **President:** Courant Student Organization 2015 – 2016
- **Organizer:** Graduate Student & Postdoc Seminar, Courant Institute 2015 – 2016

Activities to Support Diversity, Equity and Inclusion

- PhD Career Panelist, Bay Area Graduate Pathways to STEM conference 2018
- President, Courant Student Organization 2015 – 2016
  - Represented concerns of PhD student body anonymously to faculty
  - Suggested improvements for recruitment and retention of women
- Presenter, Oakland/East Bay Math Circle 2008
- Recitation section leader, UC Berkeley African Music Ensemble 2007

Software

- Primary author of open-source scientific software packages:
  - heart_valves: Model generation and fluid-structure interaction for aortic and mitral valves
  - mc_stretch: Affine-invariant, GPU parallel MCMC sampler
  - SimplifySum: Automatic simplification of symbolic sums in Mathematica
- Collaborative development of scientific software libraries: IBAMR, SimVascular, ARPREC, MatrixFFT.

Conference Presentations

1. "Simulation-Guided Design of Congenital Aortic Valve Repair," Society of Industrial and Applied Mathematics Conference on Computational Science and Engineering (CSE25), Fort Worth TX, 2025
2. "Simulation-Guided Design of Leaflet Height in Bicuspidization of the Aortic Valve," American Association for Thoracic Surgery 105^{th} Annual Meeting, Seattle WA, 2025
3. "Simulation-Guided Design of Leaflet Height in Bicuspidization of the Aortic Valve," Inaugural Stanford Cardiothoracic Surgery Annual Research Symposium, Stanford CA, 2025
4. "Simulation-Guided Design of Leaflet Height in Bicuspidization of the Aortic Valve," Bay Area Cardiovascular Research Symposium, Stanford CA, 2025
5. "Multimodal Optimization of Congenital Aortic Valve Repair," Stanford-Arizona-Morehouse-UAB Cardiovascular Research Symposium, poster, Stanford CA, 2024
6. "Multimodal Optimization of Congenital Aortic Valve Repair," Cardiac Imaging, Mechanics, and Modeling Symposium (CIM2), Stanford University, Stanford CA, 2024
7. "Simulation-Based Design of Bicuspidization of the Aortic Valve," Stanford-Cornell-Penn-Duke Cardiovascular Research Symposium, poster, Stanford CA, 2023
8. "Topics in fluid-structure interaction involving heart valves: repair of a congenital aortic valve defect," Cardiac Imaging, Mechanics, and Modeling Symposium (CIM2), Stanford University, Stanford CA, 2023

9. "Controlled Comparison of Simulated Hemodynamics across Tricuspid and Bicuspid Aortic Valves," 18^{th} International Symposium on Computer Methods in Biomechanics and Biomedical Engineering (CMBBE), Paris, France, 2023
10. "Design-Based Models of Heart Valves for Fluid-Structure Interaction," Berkeley/Stanford Computational Mechanics Festival (CompFest), Stanford CA, 2022
11. "Controlled Comparison of Simulated Hemodynamics across Tricuspid and Bicuspid Aortic Valves," Stanford-Cornell Cardiovascular Research Symposium, poster, Stanford CA, 2022
12. "Controlled Comparison of Simulated Hemodynamics across Tricuspid and Bicuspid Aortic Valves," Cardiac Imaging, Mechanics, and Modeling Symposium (CIM2), Stanford University, Stanford CA, 2022
13. "Fluid-Structure Interaction Simulations of Bicuspid Aortic Valve Disease," AHA annual meeting, virtual, 2021
14. "Design-Based Models of Heart Valves and Flow through Bicuspid Aortic Valves," 17th International Symposium on Computer Methods in Biomechanics and Biomedical Engineering (CMBBE), poster, virtual, 2021
15. "Design-Based Models of Heart Valves and Bicuspid Aortic Valve Flows" Society for Mathematical Biology Annual Meeting, virtual, 2021
16. "A Design-Based Model of the Aortic Valve," Cardiac Imaging, Mechanics, and Modeling Symposium (CIM2), Stanford University, virtual, 2020
17. "Simulating Patient-Specific Left-Ventricular Flow from Scan Data," SIAM Life Sciences meeting, (cancelled due to covid), 2020
18. "Simulations of Patient-Specific Left-Ventricular Flow", Stanford-Penn Cardiovascular Symposium, poster, Stanford CA, 2019
19. "A Design-Based Model of the Mitral Valve & Simulations of Patient-Specific Left-Ventricular Flow," Mitral Day, Boston Children's Hospital, Harvard University, Boston MA, 2019
20. "Modeling Patient-Specific Left-Ventricular Blood Flow and Mitral Valve Dynamics," 6th International Conference on Computational and Mathematical Biomedical Engineering (CMBE), Tohoku University, Sendai, Japan, 2019
21. "A Design-Based Model of the Mitral Valve & Simulations of Patient-Specific Left-Ventricular Flow," Cardiac Imaging, Mechanics, and Modeling Symposium (CIM2), Stanford University, Stanford CA, 2019
22. "Modeling the Mitral Valve," Stanford-Duke Cardiovascular Research Symposium, poster, Stanford University, Stanford CA, 2018
23. "Modeling the Mitral Valve," Bioengineering department retreat symposium, poster, Stanford University, Santa Cruz CA, 2018
24. "SimCardio: Open-Source, Multi-Physics, Cardiac Modeling and Simulation," NSF SI2 PI meeting, poster, Washington DC, 2018
25. "Modeling the Mitral Valve," American Institute of Physics Division of Fluid Dynamics Annual Meeting (APS DFD 16), Portland OR, 2016
26. "Undetected Errors in Quasi-cyclic LDPC Codes Caused by Receiver Symbol Slips," IEEE Globecom, Honolulu HI, 2009

Additional Experience

Drummer, UC Berkeley African Music Ensemble 2007 – 2009
Recitation section leader 2007

- Volunteer teaching assistant and lead drummer. Led ensemble of over one hundred people in rehearsal and performance. Ran recitation sections and tutored students in drumming, dancing and singing.

Head Coach, Berkeley Ironworks Climbing and Fitness 2008 – 2009

- Head instructor of Berkeley Ironworks Teen Team, a non-competitive rock-climbing team for teenagers. Mentored over thirty teenagers, including some with physical disabilities including cerebral palsy.

Drumming experience

- Member, *African Music Ensemble* 2009 – 2011, 2017 –
  Performed traditional music of the Ewe people of Ghana. Led by C.K. Ladzekpo of UC Berkeley Music.
- Drummer, rock bands *Cypress, Primes, Soft Signals, Scully* 2012 – 2017
  Continued playing as a hobby.
- Drummer, rock band *Magic Bullets* 2010 – 2011
  Reviewed by NY Magazine, Pitchfork.
- Drummer, rock band *Maus Haus* 2011
  Reviewed by Rolling Stone, SF Weekly.
- Drummer, rock band *Tempo No Tempo* 2004 – 2010
  Reviewed favorably by Rolling Stone, Pitchfork. Voted "Best Student Band" at Berkeley.