# Alexander D. Kaiser

adkaiser@gmail.com | 650.678.8735
alexkaiser.github.io | github.com/alexkaiser

## 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**

## Experience

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

- 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.

**Graduate Student**, Department of Mathematics 2011 – 2017
**New York University**, Courant Institute of Mathematical Sciences

- Research on modeling and simulation of cardiac fluid flow and mechanics.
- Developed new modeling methodologies called design-based elasticity for the mitral valve.
- Performed fluid-structure interaction simulations, which showed new realism and robustness over multiple cardiac cycles, enabling the computational study of this fundamental piece of the heart.
- 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).

**Consultant, Innovein Medical** 2018 – 2019

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

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

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

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

- 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 $\alpha_i$ rational, $z_i$ complex and $n$ large.
- Achieved over 1000x speedup compared to built-in algorithms in *Mathematica* on certain problems.

## Experience (continued)

**Cooperative Researcher**, Advanced Computation Group 2010
**Apple Inc.**

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

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

- 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.

## Awards and Fellowships

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

## 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. (Accepted, in press.) 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***, 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
5. 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
6. **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

7. 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
8. 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
9. Bailey DH, Borwein JM, **Kaiser AD**. Automated Simplification of Large Symbolic Expressions. *Journal of Symbolic Computation*, 2014. doi

*Conference proceedings (peer reviewed):*

10. **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
11. **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

## Preprints, Technical Reports & Conference Abstracts

1. 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. *The American Association for Thoracic Surgery Aortic Symposium*, (conference abstract) 2024. pdf
2. 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. *The American Association for Thoracic Surgery 104$^{th}$ Annual Meeting*, (conference abstract) 2024. pdf
3. **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
4. **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
5. Bao Y, **Kaiser AD**, Kaye J, Peskin CS. Gaussian-Like Immersed Boundary Kernels with Three Continuous Derivatives and Improved Translational Invariance. *Preprint*, 2017. arXiv
6. **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
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*, extended conference abstract, 2010. doi

## 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
- **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

## Teaching Experience

- Guest lecture, "Newton's Method for Numerical Solution of Nonlinear Ordinary Differential Equations," Computational and Mathematical Engineering 209: Mathematical Modeling of Biological Systems 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

## 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.

## Students Mentored

- Nicole Schiavone, Experimental validation and flow analysis in immersed boundary methods, Graduate student, Stanford University 2020-2021
- Gerald Kang, Shear stress properties in CFD, Undergraduate, Stanford University 2021
- Sandra Kong, Modeling of vascular and flows in medical devices, Undergraduate, Stanford University 2018

## 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

## Invited Seminars

1. "Design-Based Models of Heart Valves for Fluid-Structure Interaction," Fluid Mechanics Seminar, Department of Mechanical Engineering, Stanford University, 2022
2. "Design-Based Models of Heart Valves for Fluid-Structure Interaction," Computational Medicine Department Seminar, UCLA, 2022
3. "Design-Based Models of Heart Valves for Fluid-Structure Interaction," Biomechanics and Medical Devices Seminar, Department of Mechanical Engineering, UC San Diego, 2022
4. "Design-Based Models of Heart Valves for Fluid-Structure Interaction," Department of Mathematics Seminar, UC Riverside, 2022
5. "Design-Based Models of Heart Valves for Fluid-Structure Interaction," ReCoVor: Remote Colloquium on Vortex Flows, 2021
6. "Modeling the Mitral Valve," CME 300: First Year Seminar Series, Institute for Computational & Mathematical Engineering, Stanford University, 2018
7. "Modeling the Mitral Valve," Computational Biology Colloquium, Courant Institute of Mathematical Sciences, New York University, 2016
8. "Computational Experiments in Markov Chain Monte Carlo," Student Numerical Analysis and Scientific Computing Seminar, Courant Institute of Mathematical Sciences, New York University, 2016
9. "Automated Simplification of Large Symbolic Expressions," Centre for Computer Assisted Research and Applications Seminar, University of Newcastle, 2011
10. "A Testbed Based on the Motifs of Parallel Computing," Computational Research Division Seminar, Lawrence Berkeley National Laboratory, 2010

## Conference Presentations

1. "Topics in fluid-structure interaction involving heart valves: repair of a congenital aortic valve defect," Cardiac Imaging, Mechanics, and Modeling Symposium (CIM2), Stanford University, 2023
2. "Controlled Comparison of Simulated Hemodynamics across Tricuspid and Bicuspid Aortic Valves," $18^{th}$ International Symposium on Computer Methods in Biomechanics and Biomedical Engineering (CMBBE), 2023
3. "Design-Based Models of Heart Valves for Fluid-Structure Interaction," Berkeley/Stanford Computational Mechanics Festival (CompFest), 2022
4. "Controlled Comparison of Simulated Hemodynamics across Tricuspid and Bicuspid Aortic Valves," Stanford-Cornell Cardiovascular Research Symposium, poster, 2022
5. "Controlled Comparison of Simulated Hemodynamics across Tricuspid and Bicuspid Aortic Valves," Cardiac Imaging, Mechanics, and Modeling Symposium (CIM2), Stanford University, 2022
6. "Fluid-Structure Interaction Simulations of Bicuspid Aortic Valve Disease," AHA annual meeting, 2021
7. "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, 2021
8. "Design-Based Models of Heart Valves and Bicuspid Aortic Valve Flows" Society for Mathematical Biology Annual Meeting, 2021
9. "A Design-Based Model of the Aortic Valve," Cardiac Imaging, Mechanics, and Modeling Symposium (CIM2), Stanford University, 2020
10. "Simulating Patient-Specific Left-Ventricular Flow from Scan Data," SIAM Life Sciences meeting, (cancelled due to covid), 2020
11. "Simulations of Patient-Specific Left-Ventricular Flow", Stanford-Penn Cardiovascular Symposium, poster, 2019
12. "A Design-Based Model of the Mitral Valve & Simulations of Patient-Specific Left-Ventricular Flow," Mitral Day, Boston Children's Hospital, Harvard University, 2019

13. "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
14. "A Design-Based Model of the Mitral Valve & Simulations of Patient-Specific Left-Ventricular Flow," Cardiac Imaging, Mechanics, and Modeling Symposium (CIM2), Stanford University, 2019
15. "Modeling the Mitral Valve," Stanford-Duke Cardiovascular Research Symposium, poster, Stanford University, 2018
16. "Modeling the Mitral Valve," Bioengineering department retreat, poster, Stanford University, 2018
17. "SimCardio: Open-Source, Multi-Physics, Cardiac Modeling and Simulation," NSF SI2 PI meeting, poster, 2018
18. "Modeling the Mitral Valve," American Institute of Physics Division of Fluid Dynamics Annual Meeting (APS DFD 16), 2016
19. "Undetected Errors in Quasi-cyclic LDPC Codes Caused by Receiver Symbol Slips," IEEE Globecom, 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**

- 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.
- Member, *African Music Ensemble* 2009 – 2011
  Traditional music of Ewe people of Ghana. Led by C.K. Ladzekpo of UC Berkeley Music.
- Drummer, rock band *Tempo No Tempo* 2004 – 2010
  Reviewed favorably by Rolling Stone, Pitchfork. Voted "Best Student Band" at Berkeley.