Luke Zoltan Kelley

PhD Astrophysics, Harvard University, 2018

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Professional Summary

Accomplished computational scientist with a proven ability to engineer scalable simulation frameworks, optimize software systems, and extract insights from massive datasets. Recognized for technical mastery as a gravitational wave physicist. Skilled in identifying opportunities for innovation, leading cross-functional teams, and delivering transformative solutions to complex challenges on strict timelines. An effective communicator with a track record of presenting complex technical concepts to diverse audiences, from scientists to executives to non-technical stakeholders. Recognized for fostering collaboration, mentoring talent, and aligning multidisciplinary teams to achieve ambitious goals. Author of 80+ peer-reviewed papers with 8,000+ citations, including 12 first-author publications. Delivered 50+ invited colloquia and seminars, including at Harvard, Princeton, Caltech, MIT, U.Chicago, Columbia, Dartmouth, Berkeley, UCLA, and 20+ national and international conferences.

Selected Experience

Assistant Adjunct Professor, Dept. of Astronomy, UC Berkeley 2022 – present

- Pioneered advanced research techniques at the intersection of computational physics, astrophysics, large-scale cosmological simulations, and gravitational wave physics.
- Awarded $2M+ in competitive grants and fellowships, including NASA and the National Science Foundation.
- Led teams of scientists at career stages with 0–20 yrs experience (undergraduate, graduate, & postdoctoral).
  - Developed road-maps and strategic benchmarks for both near- and long- term achievements.
  - Coordinated deliverables between teams and team members to achieve group research goals.
- Mentored students and scientists, responsible for their technical and professional development.

Leader of Astrophysics Working Group, NANOGrav Collaboration 2020 – present

- Twice elected lead of astrophysics group (70+ personnel), one of four key working groups in North American NANOGrav collaboration (200+ people).
  - Coordinated technical milestones and research deliverables of subgroups responsible for completing projects as part of National Science Foundation (NSF) Physics Frontier Center funding ($17M).
  - Co-founded leadership group that coordinates and oversees individual working groups and ensures strategic alignment.
- Led a flagship project analyzing the first-ever detection of low-frequency gravitational waves, producing insights that redefined the field and garnered hundreds of academic citations.
  - Engineered and optimized a 10,000+ line codebase capable of simulating complex physical systems and processing 100s of terabytes of data on high-performance systems. Software framework is now widely used in the field as the most comprehensive physical model of its kind.
  - Led global team of 20+ experts to achieve groundbreaking advancements in simulations and gravitational wave analysis.
  - Developed parallelization techniques to produce 100x speedup in simulations, and data compression to reduce data volumes by 10x.
  - Presented project outcomes at a live National Science Foundation press event at NSF headquarters in DC, in addition to leading authorship of the discovery publication.

Postdoctoral Fellow, Dept. of Physics & Astronomy, Northwestern University 2018 – 2022

- Awarded two fellowships (Lindheimer & Cottrell) to develop the first fully self-consistent simulations of galaxy mergers and black-hole binary evolution to predict their gravitational wave signatures and electromagnetic counterparts.
- Transformed the study of low-frequency gravitational waves with 5 first-author publications, and 20 papers as contributor or advisor. Projects include:
  - Developed public software for non-parametric reconstruction of high-dimensional distributions from sparsely sampled data.
  - Engineered novel approach to ray-tracing in general relativity (non-euclidean 3+1 spacetime) that corrected numerous errors from previous calculations used in the literature since the 1990s.
  - Performed hierarchical Bayesian statistical analysis demonstrating that certain black hole populations inferred from observational datasets were heavily contaminated by false-positives.
- Designed and directed 5 independent student projects, 4 yielding first-author student publications.

Technical Skills

- **Simulations:** Designing and building end-to-end pipelines for numerical physics simulations of complex, multi-scale interacting systems; developing numerical solutions to coupled, non-linear differential equations (magnetohydrodynamics and semi-analytic models) using massive parallelization.
- **Programming Languages:** Python (Cython, MPI/parallelization), C/C++, Fortran, Javascript, HTML
- **Data Analysis:** Processing high-dimensionality datasets of 100+ TB using statistical modeling, Bayesian inference, and simulation-based methods (MCMC, Gaussian processes, normalizing flows, etc).
- **Software Development:** Designing, building and managing 10k+ line codebases with git in HPC environments, integrating parallel processing frameworks for high-performance applications.

Leadership & Communication Skills

- **Team Leadership & Mentorship**: Directed and mentored multidisciplinary teams of graduate students, postdoctoral researchers, and senior collaborators to deliver high-impact projects on tight deadlines.
- **Strategic Vision & Organization**: Managed multiple simultaneous projects by setting strategic benchmarks, aligning deliverables, and coordinating efforts across international teams.
- **Technical Communication**: Delivered 50+ invited talks at prestigious institutions (e.g., Harvard, MIT, Princeton) and 20+ international conferences, simplifying complex ideas for technical and non-technical audiences.
- **Public Engagement**: Presented scientific breakthroughs in public forums, including NSF press events and outreach talks, effectively conveying technical material to non-expert audiences and driving awareness of key initiatives.

Education

PhD, Astrophysics | Harvard University 2018
Dissertation: *Massive Black-Hole Binary Mergers: Dynamics, Environments & Expected Detections*

MA, Astrophysics | Harvard University 2013
Thesis: *Tidal Disruption Events and Magnetic Flux Capture*

BS with Honors, in Physics and Biology | University of California, Santa Cruz 2011
Physics thesis: *Coalescing Compact Binaries: implications for gravitational-wave observations*