Don E. Willcox, PhD

Physicist
Computational Scientist
Software Developer
Educator

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I'm Don, a computational physicist and most recently a project scientist at Lawrence Berkeley National Lab. I have over five years of experience developing software enabling high-impact scientific research.

Due to national funding cuts, I am pursuing opportunities to deliver numerical computing software that solves critical challenges facing today's tech industry.

Previous Position

Applied Mathematics and Computational Research Division
Lawrence Berkeley National Laboratory

Project Scientist (2022-2024)

- Created Emu, a C++ quantum radiation transport code.
- Led project training machine learning digital twin (PyTorch).
- Created parallel version of C++ quantum lattice code.
- Developed adaptive-mesh backend for ERF, a C++ weather modeling code.

Postdoctoral Researcher (2018-2022)

- Created STvAR, a CUDA C++ code for simulating PDEs.
- Developed CUDA C++ reaction network and ODE solvers.
- Led intern project modeling plasmas with the WarpX code.

Education

Ph.D., Physics (2018)
Stony Brook University – Stony Brook, NY, USA

- Developed simulations of convecting white dwarf stars.
- Developed a Python & FORTRAN nucleosynthesis code.
- Developed a CPU/GPU FORTRAN code for solving ODEs.
- Published simulations of supernovae explosions.

B.S., Engineering Physics & Electrical Engineering (2011)
LeTourneau University – Longview, TX, USA
Minors: Mathematics, Applied Sciences

Technical Proficiencies

C, C++, Fortran
Julia, Python
PyTorch, Scipy, Numpy

2D and 3D Visualization
Data Analysis Workflows

Eulerian PDE solvers (Finite Difference, Finite Volume)

Lagrangian PDE solvers (Monte Carlo, Particle-In-Cell)

Adaptive mesh refinement

Explicit ODE methods
Implicit ODE methods

Dense linear algebra
Sparse linear algebra
Complex linear algebra

OpenMP, CUDA parallelism
MPI-distributed parallelism
Benchmarking, profiling
Performance optimization

Continuous Integration
Software version control

Research Impact

26 Peer-reviewed publications, including 4 code releases in the *Journal of Open Source Software*.
Google Scholar Metrics – *h-index: 12*, *citations: 780* (Nov. 2025)

Fellowships / Awards

2011-2018 Turner Fellow, Stony Brook University Center for Inclusive Education

2007-2011 Heritage Scholarship, LeTourneau University

Funding Proposals

2023 (Partially Funded) Principal Investigator, Berkeley Lab FY 2024 Multi-Area LDRD, Co-Investigator: Hector Garcia Martin (LBNL, Biosciences Area), *Bioreactor digital twinning - Accelerating bioprocess scaling by combining computational fluid dynamics with metabolic modeling*

2023 (Not Funded) Principal Investigator, DOE Wind Energy Technologies Office, Co-Investigators: Adam Lavely (LBNL), Ganesh Vijayakumar (NREL), *Advancing AMR-Wind Turbine Simulations With Machine Learning*

2023 (Not Funded) Principal Investigator, DOE Wind Energy Technologies Office, *Artificial Intelligence for Multiscale Wind Modeling with the ERF Simulation Code*

Large Computer Time Allocations Awarded

2023 Co-Investigator on an INCITE 2023 award, *Exascale Models of Astrophysical Thermonuclear Explosions* (Awarded: 400 k node-hours on Summit, 300 k node-hours on Frontier, 100 k node-hours on Polaris)

2022 Co-Investigator on an INCITE 2022 award at OLCF, *Approaching Exascale Models of Astrophysical Explosions* (Awarded: 590 k node-hours on Summit)

2021 Senior Investigator on a NERSC 2021 Allocation, *Three-dimensional studies of white dwarfs, massive stars, and neutron star systems* (Awarded: 30 M MPP hours)

2021 Senior Investigator on a NERSC 2021 Allocation, *Neutrino Flavor Transformation in Neutron Star Mergers* (Awarded: 18 M MPP hours)

2021 Senior Investigator on a NERSC 2021 Allocation, *Rotating Superfluids via Complex Langevin* (Awarded: 17 M MPP hours)

2021 Senior Investigator on a NERSC 2021 Allocation, *Astrophysics of Supernova Progenitors* (Awarded: 13 M MPP hours)

2020 Senior Investigator on a NERSC 2020 Allocation, *Three-dimensional studies of white dwarfs, massive stars, and neutron star systems* (Awarded: 30 M MPP hours)

2019-2020 Co-Investigator on an INCITE 2019 award at OLCF, *Approaching Exascale Models of Astrophysical Explosions* (Awarded 2019: 1.5 M node-hours on Titan, 105 k node-hours on Summit; Awarded 2020: 300 k node-hours on Summit)

2018 Senior Investigator on a NERSC 2018 Allocation, *Three-dimensional studies of white dwarf and neutron star systems* (Awarded: 20.8 M MPP hours)

2018 Co-Investigator on an INCITE 2018 award at OLCF, *Approaching Exascale Models of Astrophysical Explosions* (Awarded: 40 Mh)

Scientific Software Projects

2024 Core developer of the ERF simulation code for large-scale (ie. mesoscopic) weather modeling, https://github.com/erf-model/erf

2023 Co-creator of the Emu simulation code for astrophysical neutrino quantum kinetics in 6-dimensional phase space. https://github.com/amrex-astro/Emu

2022 Core developer of the Castro simulation code for astrophysical radiation-hydrodynamics on adaptive meshes, https://github.com/amrex-astro/Castro

2020 Core developer of the StarKiller Microphysics code, a collection of publicly-available astrophysical microphysics routines and nuclear reaction network integrators, https://github.com/starkiller-astro/Microphysics

2018 Co-developer of pynucastro, a publicly-available Python interface to the JINA Reaclib nuclear reaction rate database for rate visualization and ODE right hand side code generation in Python and C++, https://github.com/pynucastro/pynucastro

2018 Co-creator of the StarSTRUQ github organization for publicly-available code implementing uncertainty quantification algorithms useful for stellar evolution calculations, https://github.com/StarSTRUQ

Professional Mentoring

2019–2021 *Co-mentor for LBNL intern - Eloise Yang*

2020–2021 *Associate mentor for Fall 2020 & Spring 2021 DOE SULI intern at LBNL - Nicole Ford*

Summer 2021 *Mentor for NSF MSGI intern at LBNL - Chris Degrendele*

Summer 2020 *Mentor for LBNL summer intern - Chris Degrendele*

Summer 2020 *Mentor for NSF MSGI intern at LBNL - Ty Frazier*

Summer 2019 *Co-mentor for LBNL summer interns - Chris Degrendele and Kiran Eiden*

Professional Service

ongoing Referee for the *Astrophysical Journal* and *Communications in Applied Mathematics and Computational Science*

2021 Organizer for SIAM CSE 2021 Minisymposium MS137, *Machine Learning Approaches in Computational Astrophysics and Cosmology*

Professional Development

2019 Participated in GPU Hackathon organized by NERSC.

2018 Participated in GPU Hackathon at Brookhaven National Laboratory.

2018 Participated in GPU Hackathon at University of Colorado, Boulder.

2018 Achieved Software Carpentry instructor certification

2017 Participated in GPU Hackathon at Brookhaven National Laboratory.

2016 Participated in GPU Hackathon hosted by the Oak Ridge Leadership Computing Facility.

2015 Participated in GPU Hackathon hosted by the Oak Ridge Leadership Computing Facility.

2015 Studied at the Argonne Training Program on Extreme-Scale Computing.

2014 Studied at the MESA Summer School for simulating massive stars, accreting white dwarfs, stellar mixing processes and more at UC Santa Barbara.

2014 Studied at the JINA TALENT Course on Nuclear Theory for Astrophysics at Michigan State University.

Community Outreach

10/20/2020 Panelist at CAUSE Career Panel, University of Minnesota

06/18/2019 Public talk at the Berkeley Public Library, Claremont, *How to Simulate a Thermonuclear Supernova*

01/2019 Judge for Chambliss poster competition at the 233rd Meeting of the American Astronomical Society.

02/21/2018 Public talk at the Astronomical Society of Long Island, Vanderbilt Museum & Planetarium, *Saturn in 13 Years: the Cassini-Huygens Mission*

11/03/2017 Public talk in the Astronomy Open Night Series, Stony Brook University, *Saturn in 13 Years: the Cassini-Huygens Mission*

Teaching Experience

LBNL

2019,2020,2021 *ATPESC Lecturer Support Staff*

Designed and presented hands-on exercises for the AMReX code at the Argonne Training Program on Extreme-Scale Computing.

Stony Brook University

Spring 2017 *WISE Computational Astrophysics*

Co-instructor for a computational astrophysics course for the Women In Science and Engineering program.

Summer 2015 *IACS Computes!*

Teaching assistant for a Python programming workshop for high school students by the Institute for Advanced Computational Sciences.

Spring 2014 *Astronomy*

Teaching assistant for an undergraduate astronomy course.

Spring 2013 *Modern Physics*

Instructor for an undergraduate laboratory on relativity and quantum mechanics.

Summer 2012 *Introduction to Calculus II*

Instructor for a 3-week course on integral calculus for incoming freshman students.

2012 *Introductory Physics*

Instructor for undergraduate laboratory on electricity and magnetism.

LeTourneau University

Fall, 2008-2010 *Electricity and Magnetism*

Recitation instructor for undergraduates taking the physics course on electricity and magnetism.

Spring 2010 *Classical Mechanics*

Recitation instructor for undergraduates taking the physics course on classical mechanics.

Don E. Willcox / Publications and Talks

Refereed Publications

26. *ERF: Energy Research and Forecasting Model*

    A. Lattanzi, A. Almgren, E. Quon, M. Natarajan, B. Kosovic, J. Mirocha, B. Perry, D. Wiersema, D. Willcox, X. Yuan, W. Zhang

    2025, Journal of Advances in Modeling Earth Systems, 17, 11

    doi.org/10.1029/2024MS004884

25. *Code Generation for AMReX with Applications to Numerical Relativity*

    A. J. Peterson, D. Willcox, and P. Moesta

    2023, Classical and Quantum Gravity, 40, 245013

    doi.org/10.1088/1361-6382/ad0b37

24. *Dimming the Lights: 2D Simulations of Deflagrations of Hybrid C/O/Ne White Dwarfs using FLASH*

    C. Feldman, N. Gutierrez, E. Eisenberg, D. E. Willcox, D. M. Townsley, A. C. Calder

    2023, Astrophysical Journal, 959, 112

    doi.org/10.3847/1538-4357/acf658

23. *ERF: Energy Research and Forecasting*

    A. Almgren, A. Lattanzi, R. Haque, P. Jha, B. Kosovic, J. Mirocha, B. Perry, E. Quon, M. Sanders, D. Wiersema, D. Willcox, X. Yuan, W. Zhang

    2023, Journal of Open Source Software, 8, 87

    doi.org/10.21105/joss.05202

22. *Particle-in-Cell Simulations of Relativistic Magnetic Reconnection with Advanced Maxwell Solver Algorithms*

    H. Klion, R. Jambunathan, M. E. Rowan, E. Yang, D. Willcox, J. L. Vay, R. Lehe, A. Myers, A. Huebl, W. Zhang

    2023, Astrophysical Journal, 952, 8

    doi.org/10.3847/1538-4357/acd75b

21. *pynucastro: A Python Library for Nuclear Astrophysics*

    A. Smith Clark, E. T. Johnson, Z. Chen, K. Eiden, D. E. Willcox, B. Boyd, L. Cao, C. J. DeGrendele, M. Zingale

    2023, Astrophysical Journal, 947, 65

    doi.org/10.3847/1538-4357/acbaff

20. *Neural Networks for Nuclear Reactions in MAESTROeX*
    D. Fan, D. E. Willcox, C. DeGrendele, M. Zingale, A. Nonaka
    2022, Astrophysical Journal, 940, 134
    doi.org/10.3847/1538-4357/ac9a4b

19. *Dark Matter from Axion Strings with Adaptive Mesh Refinement*
    M. Buschmann, J. W. Foster, A. Hook, A. Peterson, D. E. Willcox, W. Zhang, B. R. Safdi
    2022, Nature Communications, 13, 1
    doi.org/10.1038/s41467-022-28669-y

18. *Neutrino Fast Flavor Instability in Three Dimensions*
    S. Richers, D. E. Willcox, N. M. Ford
    2021, Physical Review D, 104, 103023
    doi.org/10.1103/PhysRevD.104.103023

17. *Practical Effects of Integrating Temperature with Strang Split Reactions*
    M. Zingale, M. P. Katz, D. E. Willcox, A. Harpole
    2021, Research Notes of the AAS, 5, 71
    doi.org/10.3847/2515-5172/abf3cb

16. *Dynamics of Laterally Propagating Flames in X-Ray Bursts. II. Realistic Burning and Rotation*
    A. Harpole, N. M. Ford, K. Eiden, M. Zingale, D. E. Willcox, Y. Cavecchi, M. P. Katz
    2021, Astrophysical Journal, 912, 36
    doi.org/10.3847/1538-4357/abee87

15. *Particle-in-cell Simulation of the Neutrino Fast Flavor Instability*
    S. Richers, D. E. Willcox, N. M. Ford, A. Myers
    2021, Physical Review D, 103, 083013
    doi.org/10.1103/PhysRevD.103.083013

14. *Preparing Nuclear Astrophysics for Exascale*
    M. Katz, A. Almgren, M. Barrios Sazo, K. Eiden, K. Gott, A. Harpole, J. Sexton, D. Willcox, W. Zhang, M. Zingale
    2020, Supercomputing 20 (SC20)
    doi.org/10.1109/SC41405.2020.00095

13. *CASTRO: A Massively Parallel Compressible Astrophysics Simulation Code*
    A. Almgren, M. Barrios Sazo, J. Bell, A. Harpole, M. Katz, J. Sexton, D. Willcox, W. Zhang, M. Zingale
    2020, Journal of Open Source Software, 5, 54, 2513
    doi.org/10.21105/joss.02513

12. *Dynamics of Laterally Propagating Flames in X-Ray Bursts. I. Burning Front Structure*

    K. Eiden, M. Zingale, A. Harpole, D. Willcox, Y. Cavecchi, M. P. Katz

    2020, Astrophysical Journal, 894, 6

    doi.org/10.3847/1538-4357/ab80bc

11. *The Castro AMR Simulation Code: Current and Future Developments*

    M. Zingale, A. S. Almgren, M. Barrios Sazo, J. B. Bell, K. Eiden, A. Harpole, M. P. Katz, A. J. Nonaka, D. E. Willcox, W. Zhang

    2020, Journal of Physics: Conference Series, 1623, 012021

    doi.org/10.1088/1742-6596/1623/1/012021

10. *Modelling low Mach number stellar hydrodynamics with MAESTROeX*

    A. Harpole, D. Fan, M. P. Katz, A. J. Nonaka, D. E. Willcox, M. Zingale

    2020, Journal of Physics: Conference Series, 1623, 012015

    doi.org/10.1088/1742-6596/1623/1/012015

9. *MAESTROeX: A Massively Parallel Low Mach Number Astrophysical Solver*

    D. Fan, A. Nonaka, A. Almgren, D. Willcox, A. Harpole, M. Zingale

    2019, Journal of Open Source Software, 4, 43, 1757

    doi.org/10.21105/joss.01757

8. *SN Ia Explosions from Hybrid Carbon-Oxygen-Neon White Dwarf Progenitors That Have Mixed During Cooling*

    C. N. Augustine, D. E. Willcox, J. Brooks, D. M. Townsley, A. C. Calder

    2019, Astrophysical Journal, 887, 188

    doi.org/10.3847/1538-4357/ab511a

7. *Toward Resolved Simulations of Burning Fronts in Thermonuclear X-ray Bursts*

    M. Zingale, K. Eiden, Y. Cavecchi, A. Harpole, J. B. Bell, M. Chang, I. Hawke, M. P. Katz, C. M. Malone, A. J. Nonaka, D. E. Willcox, W. Zhang

    2019, Journal of Physics: Conference Series, 1225, 012005

    doi.org/10.1088/1742-6596/1225/1/012005

6. *Thermonuclear (Type Ia) Supernovae and Progenitor Evolution*

    A. C. Calder, D. E. Willcox, C. J. DeGrendele, D. Shangase, M. Zingale, D. M. Townsley

    2019, Journal of Physics: Conference Series, 1225, 012002

    doi.org/10.1088/1742-6596/1225/1/012002

5. *Quantification of Incertitude in Black Box Simulation Codes*

    A. C. Calder, M. M. Hoffman, D. E. Willcox, M. P. Katz, F. D. Swesty, S. Ferson

    2018, Journal of Physics: Conference Series, 1031, 012016

    doi.org/10.1088/1742-6596/1031/1/012016

4. *pynucastro: an interface to nuclear reaction rates and code generator for reaction network equations*

   D. E. Willcox, M. Zingale

   2018, Journal of Open Source Software, 3(23), 588

   doi.org/10.21105/joss.00588

3. *Meeting the Challenges of Modeling Astrophysical Thermonuclear Explosions: Castro, Maestro, and the AMReX Astrophysics Suite*

   M. Zingale, A. S. Almgren, M. G. Barrios Sazo, V. E. Beckner, J. B. Bell, B. Friesen, A. M. Jacobs, M. P. Katz, C. M. Malone, A. J. Nonaka, D. E. Willcox, W. Zhang

   2018, Journal of Physics: Conference Series, 1031, 012024

   doi.org/10.1088/1742-6596/1031/1/012024

2. *Cosmic Chandlery with Thermonuclear Supernovae*

   A. C. Calder, B. K. Krueger, A. P. Jackson, D. E. Willcox, B. J. Miles, D. M. Townsley

   2017, Journal of Physics: Conference Series, 837, 012005

   doi.org/10.1088/1742-6596/837/1/012005

1. *Type Ia Supernova Explosions From Hybrid Carbon-Oxygen-Neon White Dwarf Progenitors*

   D. E. Willcox, D. M. Townsley, A. C. Calder, P. Denissenkov, F. Herwig

   2016, Astrophysical Journal, 832, 13

   doi.org/10.3847/0004-637X/832/1/13

Meeting Talks / Invited Talks / Seminars

07/15/2021 Seminar for the CS Summer Student Seminar Series, Computing Sciences, Lawrence Berkeley National Laboratory, *Supercomputing For Nuclear Astrophysics*

04/19/2021 Invited Speaker in APS April Meeting 2021 Session T05, *Neutrino Flavor Transformations with Emu: A New Particle-in-Cell Code for Quantum Kinetics*

03/02/2021 Speaker in SIAM CSE 2021 Minisymposium MS137, *Towards Surrogate Models for Nuclear Reactions in Astrophysics*

07/09/2020 Seminar for the CS Summer Student Seminar Series, Computing Sciences, Lawrence Berkeley National Laboratory, *Simulating Supernovae with Supercomputers*

01/31/2020 Talk at the 1st Annual CS Area Postdoc Symposium, Computing Sciences, Lawrence Berkeley National Laboratory, *Towards ExaScale Supernovae Simulations*

11/15/2017 Seminar for the Student Seminar Series, Institute for Advanced Computational Sciences, Stony Brook University, *Stellar Explosion Mechanics: Properties and Physical Processes in White Dwarf Interiors*

10/05/2017 Talk at the Interdisciplinary Theoretical and Computational Physical Science meeting, Tokyo Institute of Technology, Japan, *The Dynamics and Origins of Thermonuclear (Type Ia) Supernovae*

09/29/2017 Talk at NY Area Computational Hydro Workshop, Flatiron Institute/CCA, *A Brief Tour of the AMReX Astrophysics Suite of Codes*

06/28/2017 Seminar for the Research Café Series, Center for Inclusive Education, Stony Brook University, *White Dwarfs as Type Ia Supernovae Progenitors*

06/16/2017 Invited talk at Current Challenges in the Physics of White Dwarf Stars, Santa Fe, NM, *Simulations of Various White Dwarf Progenitor Models for Type Ia Supernovae*

06/14/2017 Invited astrophysics seminar at Los Alamos National Laboratory, NM, *Status of Recent Work for Type Ia Supernovae Progenitors: Hybrid C-O-Ne White Dwarfs, the Convective Urca Process, and Accelerated Reaction Networks*

02/05/2017 Talk at JINA-CEE Frontiers in Nuclear Astrophysics: Junior Researchers Workshop, Michigan State University, *Elucidating the Convective Urca Process in Pre-Supernova White Dwarfs Using Three-Dimensional Simulations*

Conference Posters

13. *SedonaEx: A Monte Carlo Radiation Transfer Code for Astrophysical Events,*

    D. E. Willcox, A. S. Almgren, D. Kasen, A. Myers, & W. Zhang

    SIAM CSE 2019 Meeting, Spokane, WA (Best Poster Prize)

12. *Visualizing Nuclear Reaction Rates and Constructing Networks with pynucastro*

    D. E. Willcox, A. Jacobs, X. Li, & M. Zingale

    2019, American Astronomical Society Meeting 233, 457.05

11. *Computational Astrophysics and Cosmology*

    D. Fan, J. Sexton, & D. Willcox

    2019, Computational Research Division Capability Review, Lawrence Berkeley National Laboratory

10. *pynucastro: Code Generation and Visualization for Nuclear Reaction Networks,*

    D. E. Willcox, A. Jacobs, X. Li, & M. Zingale

    Bay Area Scientific Computing Day 2018, Sandia National Laboratories, Livermore, CA, December 7, 2018.

9. *Three Dimensional Simulations of the Convective Urca Process in White Dwarf Progenitors of Type Ia Supernovae,*

    D. E. Willcox, D. M. Townsley, M. Zingale, & A. C. Calder

    2017, Current Challenges in the Physics of White Dwarf Stars, Santa Fe, NM, June 12-16, 2017.

8. *Elucidating the Convective Urca Process in Pre-Supernova White Dwarfs Using Three-Dimensional Simulations,*

    D. E. Willcox, D. M. Townsley, M. Zingale, & A. C. Calder

    2017, JINA-CEE Frontiers in Nuclear Astrophysics Meeting, February 7-9, 2017.

7. *Three-Dimensional Simulations of the Convective Urca Process in Pre-Supernova White Dwarfs,*
   D. E. Willcox, D. M. Townsley, M. Zingale, & A. C. Calder
   2017, American Astronomical Society Meeting 229, 244.05

6. *On the Quantification of Incertitude in Astrophysical Simulation Codes,*
   M. M. Hoffman, M. P. Katz, D. E. Willcox, S. Ferson, F. D. Swesty, & A. C. Calder
   2017, American Astronomical Society Meeting 229, 154.27

5. *Thermonuclear Supernova Explosions From Hybrid White Dwarf Progenitors,*
   D. E. Willcox, D. M. Townsley, A. C. Calder, P. Denissenkov, & F. Herwig
   2016, American Astronomical Society Meeting 227, 237.17

4. *A Comparison of Type Ia Supernovae with C-O and Hybrid C-O-Ne White Dwarf Progenitors,*
   D. E. Willcox, D. M. Townsley, A. C. Calder, P. Denissenkov, & F. Herwig
   2015, F.O.E. Fifty-One Erg International Workshop, North Carolina State University, NC.

3. *A Study of Steady-State Detonation Structures for Hybrid C, O, Ne White Dwarf Models,*
   D. E. Willcox, D. M. Townsley, & A. C. Calder
   2014, International Conference: "Type Ia Supernovae: Progenitors, Explosions, and Cosmology," University of Chicago, IL.

2. *Imaging Molecular Structure With High Harmonics,*
   D. E. Willcox, M. A. Reber, Y. Chen, K. Halder, & T. Allison
   2013, Chemistry Research Day, Stony Brook University, NY.

1. *Cavity-Enhanced Transient Absorption Spectroscopy,*
   M. A. Reber, Y. Chen, D. E. Willcox, & T. Allison
   2013, Chemistry Research Day, Stony Brook University, NY.

Non-Refereed Conference Proceedings

3. *Implementation of Digital Radio Mondiale receiver - Part II,*
   D. E. Willcox, J. Kim, & J. Wineman
   2011, IEEE 43rd Southeastern Symposium on System Theory, Auburn, AL, March 2011.

2. *Implementation of Digital Radio Mondiale Receiver - Part I,*
   D. E. Willcox, J. Kim, C. Loewen, & J. Wineman
   2010, IEEE 42nd Southeastern Symposium on System Theory, Tyler, TX, March 2010.

1. *Diversity Receiver for Digital Radio Mondiale - a multi-year design project,*
   P. Leiffer, J. Kim, R. W. Graff, & D. E. Willcox
   2010, ASEE 2010 Annual Conference & Exposition, Louisville, KY, June 2010.