Donald E. Willcox / Curriculum Vitæ

Computational Research Division
Lawrence Berkeley National Laboratory
1 Cyclotron Road Mailstop 50A3111
Berkeley, CA 94720

tel: (903)-399-8451

email: DEWillcox@lbl.gov

web: https://dwillcox.github.io

github: dwillcox

Present Position:

2018– *Postdoctoral Researcher*, Center for Computational Sciences & Engineering, Lawrence Berkeley National Laboratory

Research Interests:

I am a postdoctoral researcher in the Center for Computational Sciences and Engineering (CCSE) in the Computational Research Division at Berkeley Lab. My research in computational astrophysics began with designing large scale hydrodynamics simulations of supernova explosions. I then developed efficient algorithms for ODE integration to model nuclear burning in various astrophysical processes and accelerated these algorithms for GPU-based supercomputers. I have also developed the Emu code for simulating multidimensional neutrino quantum kinetics for supernovae and neutron star merger studies. Most recently, I am interested in applying the computational techniques I learned doing astrophysics to various terrestrial domains, including atmospheric science.

Education:

Stony Brook University – Stony Brook, NY, USA

Ph.D., Physics, August 2018

LeTourneau University – Longview, TX, USA

B.S., Engineering Physics, May 2011
B.S., Electrical Engineering, May 2011
Minors: Mathematics, Applied Sciences

Fellowships / Awards:

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

2007-2011 Heritage Scholarship, LeTourneau University

Large Computer Time Allocations:

2022 Co-Investigator on an INCITE 2022 award at OLCF, *Approaching Exascale Models of Astrophysical Explosions* (2022: 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* (30 M MPP hours)

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

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

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

2019-2020 Co-Investigator on an INCITE 2019 award at OLCF, *Approaching Exascale Models of Astrophysical Explosions* (2019: 1.5 M node-hours on Titan, 105 k node-hours on Summit; 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* (20.8 M MPP hours)

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

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, 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 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 Student at the Argonne Training Program on Extreme-Scale Computing.

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

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

Software Projects:

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

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

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

ongoing 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 generation, https://github.com/pynucastro/pynucastro

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

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*

Weekly recitation instructor for undergraduates.

Spring 2010   *Classical Mechanics*

Weekly recitation instructor for undergraduates.

Donald E. Willcox / Publications and Talks

Refereed Publications:

17. *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
    2021, Submitted to Nature Physics, arXiv 2108.05368

16. *The Neutrino Fast Flavor Instability in Three Dimensions*
    S. Richers, D. E. Willcox, & N. M. Ford
    2021, Accepted to Physical Review D, arXiv 2109.08631

15. *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

14. *Dynamics of Laterally Propagating Flames in X-Ray Bursts. II. Realistic Burning &
    Rotation*
    A. Harpole, N. M. Ford, K. Eiden, M. Zingale, D. E. Willcox, Y. Cavecchi, & M. P. Katz
    2021, Astrophysical Journal, 912, 36

13. *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

12. *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
    Published in Supercomputing 20.

11. *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, 1

10. *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, 2

 9. *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
    2019, arXiv 1910.12578, Submitted to proceedings of Astronum 2019.

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

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

   2019, arXiv 1910.12979, Submitted to proceedings of Astronum 2019.

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

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

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

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

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

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

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

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.

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.