

JOSHUA W. BURBY

Department of Physics, University of Texas at Austin
joshua.burby@austin.utexas.edu

EDUCATION

Princeton University	PhD, Plasma Physics	2010 - 2015
Cornell University	BS, Engineering Physics	2006 - 2010

PROFESSIONAL EXPERIENCE

The University of Texas at Austin	January 2024 - Present
<i>Assistant Professor</i>	
Los Alamos National Laboratory	December 2021 - December 2023
<i>Scientist</i>	
Los Alamos National Laboratory	January 2019 - December 2021
<i>Feynman Postdoctoral Fellow</i>	
Mathematical Sciences Research Institute	September 2018 - December 2018
<i>Viterbi Postdoctoral Fellow</i>	
Noble Artificial Intelligence	June 2018 - October 2018
<i>Lead Research Scientist</i>	
Courant Institute of Mathematical Sciences	September 2015 - June 2018
<i>DOE FES Postdoctoral Fellow</i>	

GRANTS

Institute for Fusion Studies	September 2025
Role: <i>CO-I</i>	
Funded by: <i>DOE FES</i>	
Amount: \$2,800,000 <i>over 2.5 yrs</i>	
Early Career Research Award	November 2022
Role: <i>PI</i>	
Funded by: <i>LANL Laboratory Directed Research and Development (LDRD)</i>	
Title: <i>Fragment kinetics for strongly-radiating plasmas</i>	
Amount: \$480,000 <i>over 2 yrs</i>	
Mathematical Multifaceted Integrated Capabilities	
Center Grant	October 2022
Role: <i>CO-PI</i>	
Funded by: <i>DOE Advanced Scientific Computing Research (ASCR) program</i>	
Title: <i>CHaRMNET</i>	
Amount: \$2,875,000 <i>over 5 yrs</i>	
LDRD DR Grant	October 2022
Role: <i>CO-PI</i>	
Funded by: <i>LANL Laboratory Directed Research and Development (LDRD)</i>	
Title: <i>Advancing the Mission: Sparse View Dynamic Tomographic Reconstruction for 3D Code Validation</i>	
Amount: \$2,000,000 <i>over 3 yrs</i>	

Data-Intensive Scientific Machine Learning
and Analysis Grant

April 2021

Role: *CO-PI*

Funded by: *DOE Advanced Scientific Computing Research (ASCR) program*

Title: *Inertial neural surrogates for stable dynamical prediction*

Amount: \$3,500,000 over 3 yrs

TEACHING EXPERIENCE

Graduate Teaching Assistant 2012

Course name: *Asymptotic methods*

Location: *Princeton University*

Graduate Teaching Assistant 2013

Course name: *Non-neutral plasma physics*

Location: *Princeton University*

Invited lecturer 2015

Lecture series name: *ITER International School*

Location: *Hefei, China*

Guest lecturer at USTC 2015

Lecture series name: *Variational principles*

Location: *University of Science and Technology of China (USTC), China*

Guest lecturer at Princeton University 2016

Lecture series name: *Variational principles for gyrokinetics*

Location: *Princeton University*

Invited lecturer at KineMa 2016

Lecture series name: *Variational principles for gyrokinetics*

Location: *Institut d'Etudes Scientifiques de Cargese*

Guest lecturer at University of New Mexico 2019

Lecture series name: *Object oriented programming and scientific computing*

Location: *University of New Mexico*

Summer student mentor 2019

Mentee: *Taylor J. Klotz, PhD Candidate, CU Boulder*

Topic: *Slow manifold reduction for quasineutral plasmas*

Location: *Los Alamos National Laboratory*

Summer student mentor 2022

Mentee: *Valentin Duruisseaux, PhD Candidate, UC San Diego*

Topic: *Structure-preserving machine learning for non-dissipative systems*

Location: *Los Alamos National Laboratory*

Summer student mentor 2022

Mentee: *George Kevrekidis, PhD Candidate, Johns Hopkins Univeristy*

Topic: *Symplectic neural networks and equation of state*

Location: *Los Alamos National Laboratory*

Postdoc mentor	2022
Mentee: <i>Daniel A. Serino, PhD</i>	
Topic: <i>Structure-preserving machine learning for dissipative systems</i>	
Location: <i>Los Alamos National Laboratory</i>	
Postdoc mentor	2022
Mentee: <i>Allen Alvarez Loya, PhD</i>	
Topic: <i>Structure-preserving machine learning</i>	
Location: <i>Los Alamos National Laboratory</i>	
Instructor	2024
Course name: <i>PHY 301. Mechanics</i>	
Location: <i>UT Austin</i>	
Instructor	2025
Course name: <i>PHY 385K. Classical Mechanics</i>	
Location: <i>UT Austin</i>	
Instructor	2025
Course name: <i>PHY 336K. Classical Dynamics</i>	
Location: <i>UT Austin</i>	

COMMUNITY SERVICE

- UT Austin Physics Department Climate Committee member 2024-present
 - Participant in LANL Theoretical Division Diversity and Inclusion Working Group
 - Regular reviewer for physics journals including Physics of Plasmas, Journal of Plasma Physics, Journal of Physics A, and Journal of Computational Physics
 - Co-organized 2021 Flash GAMP: An online seminar series on Geometric Algorithms and Methods in Physics
 - Co-organized 2020 T-5 summer student program
- | | |
|---|------|
| Qualifying Exam | 2025 |
| Student: <i>Mandela Bright Quashie</i> | |
| Institution: <i>Michigan State University</i> | |
| Title: <i>Moment-Enhanced Particle-in-Cell (PIC) Method</i> | |

INVITED TALKS

Simons hour	2024
Title: <i>Spatial dynamics formulation of magnetohydrostatics</i>	
Location: <i>Webinar</i>	
66th Annual Meeting of the APS Division of Plasma Physics	2024
Title: <i>Poisson-Dirac submanifolds as a paradigm for imposing constraints in non-dissipative plasma models</i>	
Location: <i>Atlanta, GA</i>	

Simons Collaboration on Hidden Symmetries and Fusion Energy	2025
Title: <i>The nonperturbative adiabatic invariant is all you need</i>	
Location: <i>Gerald D. Fischbach Auditorium, NY</i>	
International Conference on Fundamental Plasma Physics	2025
Title: <i>The nonperturbative adiabatic invariant is all you need</i>	
Location: <i>Austin, TX</i>	

PUBLICATIONS

- [78] Y. Zhao, J. W. Burby, A. Christlieb, and H. Lei, “Data-driven construction of a generalized kinetic collision operator from molecular dynamics,” *Phys. Rev. Lett.* 135:185101 (2025).
- [77] M. Updike and J. W. Burby, “Is there an exact magnetic-moment for charged particle motion in a homogeneous, time-dependent magnetic field?,” *arXiv Preprint*, arXiv:2509.03641, [Submitted to *J. Fund. Plasma Phys.*] (2025).
- [76] I. Hollas, R. Agarwal, J. W. Burby, and A. J. Brizard, “Exact expressions for nonperturbative guiding center theory in symmetric fields,” *arXiv Preprint*, arXiv:2508.09484, [Submitted to *J. Fund. Plasma Phys.*] (2025).
- [75] D. A. Kaltsas, J. W. Burby, P. J. Morrison, E. Tassi, and G. N. Throumoulopoulos, “Imposing quasineutrality on electrostatic plasmas via the Dirac theory of constraints,” *arXiv Preprint*, arXiv:2508.02389, [Submitted to *J. Plasma Phys.*] (2025).
- [74] F. W. Pinto and J. W. Burby, “Poisson-Dirac submanifolds as a paradigm for imposing constraints in non-dissipative plasma models,” *Phys. Plasmas* 32:072305 (2025).
- [73] D. A. Serino, A. A. Loya, J. W. Burby, I. G. Kevrekidis, and Q. Tang, “Fast-slow neural networks for learning singularly perturbed dynamical systems,” *J. Comp. Phys.* 537:114090 (2025).
- [72] J. W. Burby, D. A. Kaltsas, P. J. Morrison, E. Tassi, and G. N. Throumoulopoulos, “Hamiltonian formulation of the quasineutral Vlasov-Poisson system,” *arXiv Preprint*, arXiv:2506.21415, [Submitted to *J. Math. Phys.*] (2025).
- [71] M. Ruth, J. Kulik, and J. W. Burby, “Robust computation of higher-dimensional invariant tori from individual trajectories,” *arXiv Preprint*, arXiv:2505.08715, [Submitted to *Chaos*] (2025).
- [70] J. W. Burby, I. A. Maldonado, M. Ruth, D. A. Messenger, and L. Carbajal, “Nonperturbative guiding center model for magnetized plasmas,” *Phys. Rev. Lett.* 134:175101 (2025).
- [69] J. W. Burby, N. Kallinikos, R. S. MacKay, D. Perrella, and D. Pfefferle, “Characterization of admissible quasisymmetries,” *J. Plasma Phys.* 91:E33 (2025).
- [68] G. A. Kevrekidis, D. A. Serino, M. A. R. Kaltenborn, J. T. Gammel, J. W. Burby, and M. L. Klasky, “Neural network representations of multiphase equations of state,” *Sci. Rep.* 14:1–13 (2024).

- [67] D. A. Messenger, J. W. Burby, and D. M. Bortz, “Coarse-graining Hamiltonian systems using WSINDy,” *Sci. Rep.* 14:14457 (2024).
- [66] B. K. Tran, J. W. Burby, and B. S. Southworth, “A geometric perspective on kinetic matter-radiation interaction and moment systems,” *arXiv Preprint*, arXiv:2409.11495, [Submitted to *Geometric Mechanics*, IN PRESS] (2024).
- [65] W. T. Taitano, J. W. Burby, and A. Alekseenko, “A conditional formulation of the Vlasov-Ampere equations: A conservative, positivity, asymptotic, and Gauss law preserving scheme,” *arXiv Preprint*, arXiv:2410.20106, [Submitted to *J. Comp. Phys.*] (2024).
- [64] C-K. Huang, Q. Tang, Y. K. Batygin, O. Beznosov, J. W. Burby, A. Kim, S. Kurennoy, T. Kwan, and H. N. Rakotoarivelo, “Symplectic neural surrogate models for beam dynamics,” *J. Phys.: Conf. Ser.* 2687:062026 (2024).
- [63] J. W. Burby, “Variable-moment fluid closures with Hamiltonian structure,” *Sci. Rep.* 13:18286 (2023).
- [62] V. Duruisseaux, J. W. Burby, and Q. Tang, “Approximation of nearly-periodic symplectic maps via structure-preserving neural networks,” *Sci. Rep.* 13:8351 (2023).
- [61] J. W. Burby, N. Duignan, and J. D. Meiss, “Minimizing separatrix crossing through isoprominence,” *Plasma Phys. Control. Fusion* 65:045004 (2023).
- [60] M. Updike and J. W. Burby, “A BBGKY-like hierarchy for quantum field theories,” *arXiv Preprint*, arXiv:2310.10940, (2023).
- [59] J. W. Burby and M. H. Updike, “Spatial dynamics formulation of magnetohydrostatics,” *arXiv Preprint*, arXiv:2310.16220, (2023).
- [58] J. W. Burby, J. M. Finn, and C. L. Ellison, “Improved accuracy in degenerate variational integrators for guiding center and magnetic field line flow,” *Phys. Plasmas* 29:083501 (2022).
- [57] J. W. Burby and P. J. Morrison, “Mean field theory for intense light-matter interactions in high energy density plasmas,” *arXiv Preprint*, arXiv:2211.13371, (2022).
- [56] J. W. Burby, R. S. MacKay, and S. Naik, “Isodrastic magnetic fields for suppressing transitions in guiding-centre motion,” *Nonlinearity* 36:5884 (2022).
- [55] A. J. Linot, J. W. Burby, Q. Tang, P. Balaprakash, M. D. Graham, and R. Maulik, “Stabilized Neural Ordinary Differential Equations for Long-Time Forecasting of Dynamical Systems,” *arXiv Preprint*, arXiv:2203.15706, [Submitted to *J. Comp. Phys.*] (2022).
- [54] J. W. Burby, “Slow manifold reduction as a systematic tool for revealing the geometry of phase space,” *Phys. Plasmas* 29:042102 (2022).
- [53] M. Hossain, O. Korobkin, M. L. Klasky, J. L. Shei, J. W. Burby, M. T. McCann, T. Wilcox, S. De, and C. Bouman, “High-precision inversion of dynamic radiography using hydrodynamic features,” *Optics Express* 30:14432 (2022).
- [52] E. Hirvijoki, J. W. Burby, and A. J. Brizard, “Metriplectic foundations of gyrokinetic Vlasov–Maxwell–Landau theory,” *Phys. Plasmas* 29:060701 (2022).

- [51] J. W. Burby, E. Hirvijoki, and M. Leok, “Nearly-periodic maps and geometric integration of noncanonical Hamiltonian systems,” *arXiv Preprint*, arXiv:2112.08527, [Submitted to *J. Nonlin. Sci.*] (2021).
- [50] F. Zonta, R. Iorio, J. W. Burby, C. Liu, and E. Hirvijoki, “Dispersion relation for gauge-free electromagnetic drift kinetics,” *Phys. Plasmas* 28:092504 (2021).
- [49] G. Miloshevich and J. W. Burby, “Hamiltonian reduction of Vlasov-Maxwell to a dark slow manifold,” *J. Plasma Phys.* 87:835870301 (2021).
- [48] J. W. Burby and E. Hirvijoki, “Normal stability of slow manifolds in nearly-periodic Hamiltonian systems,” *J. Math. Phys.* 62:093506 (2021).
- [47] J. W. Burby, N. Duignan, and J. Meiss, “Integrability, normal forms, and magnetic axis coordinates,” *J. Math. Phys.* 62:122901 (2021).
- [46] J. W. Burby, N. Kallinikos, and R. S. MacKay, “Approximate symmetries of guiding-centre motion,” *J. Phys. A* 54:125202 (2021).
- [45] J. B. Parker, J. W. Burby, J. B. Marston, and S. M. Tobias, “Nontrivial topology in the continuous spectrum of a magnetized plasma,” *Phys. Rev. Res.* 2:033425 (2020).
- [44] J. W. Burby, N. Kallinikos, and R. S. MacKay, “Some mathematics for quasi-symmetry,” *J. Math. Phys.* 61:093503 (2020).
- [43] E. Hirvijoki and J. W. Burby, “Collisional gyrokinetics teases the existence of metriplectic reduction,” *Phys. Plasmas* 27:082307 (2020).
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- [40] J. W. Burby, Q. Tang, and R. Maulik, “Fast neural Poincaré maps for toroidal magnetic fields,” *Plasma Phys. Control. Fusion* 63:024001 (2020).
- [39] J. W. Burby and J. Squire, “General formulas for adiabatic invariants in nearly periodic Hamiltonian systems,” *J. Plasma Phys.* 86:835860601 (2020).
- [38] R. Maulik, N. A. Garland, J. W. Burby, X.-Z. Tang, and P. Balaprakash, “Neural network representability of fully ionized plasma fluid model closures,” *Phys. Plasmas* 27:072106 (2020).
- [37] J. W. Burby and T. J. Klotz, “Slow manifold reduction for plasma science,” *Commun. Nonlin. Sci. Numer. Simul.* 89:105289 (2020).
- [36] E. Hirvijoki, J. W. Burby, D. Pfefferlé, and A. J. Brizard, “Energy and momentum conservation in the Euler-Poincaré formulation of local Vlasov-Maxwell-type systems,” *J. Phys. A: Math. Theo.* 53:235204 (2020).
- [35] J. W. Burby and D. E. Ruiz, “Variational nonlinear WKB in the Eulerian frame,” *J. Math. Phys.* 61:053101 (2020).
- [34] J. W. Burby, “Guiding center dynamics as motion on a formal slow manifold in loop space,” *J. Math. Phys.* 61:012703 (2020).

- [33] J. W. Burby and A. J. Brizard, “Gauge-free electromagnetic gyrokinetic theory,” *Phys. Lett. A* 383:2172–2175 (2019).
- [32] C. L. Ellison, J. M. Finn, J. W. Burby, M. Kraus, H. Qin, and W. M. Tang, “Degenerate variational integrators for magnetic field line flow and guiding center trajectories,” *Phys. Plasmas* 25:052502 (2018).
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- [29] E. Hirvijoki, J. W. Burby, and M. Kraus, “Energy-, momentum-, density-, and positivity-preserving spatio-temporal discretizations for the nonlinear Landau collision operator with exact H-theorems,” *arXiv Preprint*, arXiv:1804.08546, (2018).
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- [27] J. W. Burby, “Finite-dimensional collisionless kinetic theory,” *Phys. Plasmas* 24:032101 (2017).
- [26] J. W. Burby, “Magnetohydrodynamic motion of a two-fluid plasma,” *Phys. Plasmas* 24:082104 (2017).
- [25] J. W. Burby and C. Tronci, “Variational approach to low-frequency kinetic-MHD in the current coupling scheme,” *Plasma Phys. Contr. Fusion* 59:045013 (2017).
- [24] J. W. Burby and C. L. Ellison, “Toroidal regularization of the guiding center Lagrangian,” *Phys. Plasmas* 24:110703 (2017).
- [23] A. D. Washburne, J. W. Burby, and D. Lacker, “Novel covariance-based neutrality test of time-series data reveals asymmetries in ecological and economic systems,” *PLoS Comp. Bio.* 12:e1005124 (2016).
- [22] A. J. Brizard, P. J. Morrison, J. W. Burby, L. de Guillebon, and M. Vittot, “Lifting of the Vlasov-Maxwell bracket by Lie transform method,” *J. Plasma Phys.* 82:905820608 (2016).
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- [20] C. L. Ellison, J. W. Burby, and H. Qin, “Comment on ‘Symplectic integration of magnetic systems’: a proof that the Boris algorithm is not variational,” *J. Comp. Phys.* 301:489–493 (2015).
- [19] H. Qin, M. Chung, R. C. Davidson, and J. W. Burby, “Spectral and structural stability properties of charged particle dynamics in coupled lattices,” *Phys. Plasmas* 22:056702 (2015).
- [18] J. W. Burby, “Chasing Hamiltonian structure in gyrokinetic theory,” Ph.D. Thesis, Princeton University. (2015).
- [17] J. W. Burby and A. J. Brizard, “Energetically consistent collisional gyrokinetics,” *Phys. Plasmas* 22:100707 (2015).

- [16] J. W. Burby, A. J. Brizard, P. J. Morrison, and H. Qin, “Hamiltonian gyrokinetic Vlasov-Maxwell system,” *Phys. Lett. A* 379:2073-2077 (2015).
- [15] H. Qin, J. Liu, J. Xiao, R. Zhang, Y. He, Y. Wang, Y. Sun, J. W. Burby, L. Ellison, and Y. Zhou, “Canonical symplectic particle-in-cell method for long-term large-scale simulations of the Vlasov-Maxwell equations,” *Nucl. Fusion* 56:014001 (2015).
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- [13] Y. Zhou, H. Qin, J. W. Burby, and A. Bhattacharjee, “Variational integration for ideal magnetohydrodynamics with built-in advection equations,” *Phys. Plasmas* 21:102109 (2014).
- [12] F. I. Parra, I. Calvo, J. W. Burby, J. Squire, and H. Qin, “Equivalence of two independent calculations of the higher order guiding center Lagrangian,” *Phys. Plasmas* 21:104506 (2014).
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- [9] J. Squire, J. W. Burby, and H. Qin, “VEST: Abstract vector calculus simplification in Mathematica,” *Comp. Phys. Comm.* 185:128–135 (2014).
- [8] J. W. Burby and H. Qin, “Hamiltonian mechanics of generalized eikonal waves,” *arXiv Preprint*, arXiv:1405.1689, (2014).
- [7] J. W. Burby, C. L. Ellison, and H. Qin, “Variational integrators for perturbed non-canonical Hamiltonian systems,” *arXiv Preprint*, arXiv:1405.1698, (2014).
- [6] H. Qin, R. C. Davidson, M. Chung, and J. W. Burby, “Generalized Courant-Snyder theory for charged-particle dynamics in general focusing lattices,” *Phys. Rev. Lett.* 111:104801 (2013).
- [5] J. W. Burby and H. Qin, “Toroidal precession as a geometric phase,” *Phys. Plasmas* 20:012511 (2013).
- [4] J. W. Burby, J. Squire, and H. Qin, “Automation of the guiding center expansion,” *Phys. Plasmas* 20:072105 (2013).
- [3] J. W. Burby, A. I. Zhmoginov, and H. Qin, “Hamiltonian mechanics of stochastic acceleration,” *Phys. Rev. Lett.* 111:195001 (2013).
- [2] Y. Zhou, J. W. Burby, and H. Qin, “A Lagrangian perspective on the stability of ideal MHD equilibria with flow,” *arXiv Preprint*, arXiv:1305.5448, (2013).
- [1] J. W. Burby and H. Qin, “Gyrosymmetry: global considerations,” *Phys. Plasmas* 19:052106 (2012).