Elizabeth J. Paul

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Education

Ph.D. 2020, University of Maryland College Park, Physics
- Thesis: "Adjoint methods for stellarator shape optimization and sensitivity analysis"
- Advisor: William Dorland

A.B. 2015, Princeton University, Astrophysical Sciences, Magna Cum Laude
- Certificates in Applied and Computational Mathematics, Applications of Computing
- Thesis: "Passive tracers in ATHENA: implementation and applications for turbulent star formation"

Experience

Assistant Professor, Applied Physics, Columbia University, January 2023-present
Presidential Postdoctoral Research Fellow, Princeton University, July 2020-December 2022

Awards

- DOE Early Career Award (2023)
- American Physical Society Marshall N. Rosenbluth Outstanding Doctoral Thesis Award (2021)
- DOE Office of Workforce Development Student Mentorship Award (2021)
- UMD Physics Monroe H. Martin Graduate Research Fellowship (2020)
- ARCS Foundation Fellowship (2019)
- UMD Graduate School Outstanding Research Assistant Award (2018)
- Graduate Student Poster Prize, Sherwood Fusion Theory Conference (2017)
- UMD Physics Dean's Fellowship (2015)

Publications [h-index: 12, Citations: 506 (April 1, 2025)]
Undergraduate students under my primary supervision
Graduate students under my primary supervision
Postdocs under my primary supervision

31. **E. J. Paul**, **A. Hyder**, E. Rodríguez, R. Jorge, **A. Knyazev** "The shear Alfvén continuum of quasisymmetric stellarators. Part 1. Perturbation theory," *under review with Journal of Plasma Physics* (2025).

30. **A. Baillod**, **E. J. Paul**, T. Elder, **J. Halpern**, "Enhancing Stellarator Accessibility through Port Size Optimization," *under review with Nuclear Fusion* (2025).

29. **A. Chambliss**, **E. J. Paul**, S. R. Hudson, "Fast particle trajectories and integrability in quasiaxisymmetric and quasihelical stellarators," *accepted to Journal of Plasma Physics* (2024).

28. P. Huslage, **E. J. Paul**, **M. Haque**, P. Gil, N. Foppiani, J. Smoniewsk, E. Stenson, "Strain Optimization for ReBCO High-Temperature Superconducting Stellarator Coils in SIMSOPT," *under review with Journal of Plasma Physics* (2024).

27. A. Kaptanoglu, A. Wiedman, **J. Halpern**, S. Hurwitz, **E. J. Paul**, M. Landreman, "Reactor-scale stellarators with force and torque minimized dipole coils," *Nuclear Fusion* 65, 046029 (2025).

26. S. Guinchard, S. Hudson, **E. J. Paul**, "Including the vacuum energy in stellarator coil design," *Plasma Physics and Controlled Fusion* 67, 035028 (2025).

25. M. Yoshida, R. McDermott, C. Angioni, Y. Camenen, J. Citrin, M. Jakubowski, J. Hughes, Y. Idomura, P. Mantica, A. Mariani, S. Mordijck, **E. J. Paul**, T. Tala, G. Verdoolaege, A. Zocco, F. Casson, G. Dif-Pradalier, B. Duval, B. Grierson, S. Kaye, P. Manas, M. Maslov, T. Odstrcil, J. Rice, L. Schmitz, F. Sciortino, E. Solano, G. Staebler, M. Valovic, E. Wolfrum, J. Snipes, "Transport and confinement physics: Chapter 2 of the special issue: on the path to tokamak burning plasma operation," *Nuclear Fusion* 65, 033001 (2025).

24. L. Fu, **E. J. Paul**, A. Kaptanoglu, A. Bhattacharjee, "Global stellarator coil optimization with quadratic constraints and objectives," *Nuclear Fusion* 65, 026045 (2025).

23. **A. Baillod**, **E. J. Paul**, **G. Rawlinson**, **M. Haque**, **S. W. Freiberger**, **S. Thapa**, "Integrating novel stellarator single-stage optimization algorithms to design the Columbia Stellarator Experiment," *Nuclear Fusion* 65, 026046 (2025).

22. **R. Nies**, **E. J. Paul**, D. Panici, S.R. Hudson, A. Bhattacharjee, "Exploration of the parameter space of quasisymmetric stellarator vacuum fields through adjoint optimization," *Journal of Plasma Physics* 90, 905900620 (2024).

21. **E. J. Paul**, H. Mynick, A. Bhattacharjee, "Fast ion transport in quasisymmetric equilibria in the presence of a resonant Alfvénic perturbation,'' *Journal of Plasma Physics* 89, 905890515 (2023).

20. W. Sengupta, N. Nikulsin, **E. J. Paul**, S. Buller, R. Nies, S. R. Hudson, A. Bhattacharjee, "Periodic Korteweg-de Vries soliton potentials generate magnetic field strength with exact quasisymmetry," *submitted to Physical Review Letters* (2023).

19. **B. Lee**, **E. J. Paul**, G. Stadler, and M. Landreman, "Stellarator coil optimization supporting multiple magnetic configurations," *Nuclear Fusion Letters* 63, 014002 (2022).

18. **E. J. Paul**, A. Bhattacharjee, M. Landreman, D. Alex, J. L. Velasco, and R. Nies, "Energetic particle loss mechanisms in reactor-scale equilibria close to quasisymmetry," *Nuclear Fusion* 62, 126054 (2022).

17. P. Helander, S. R. Hudson, and **E. J. Paul**, "Heat conduction in an irregular magnetic field: Part I. Heat conduction in irregular magnetic fields," *Journal of Plasma Physics* 88, 905880122 (2022).

15. E. Rodriguez, **E. J. Paul**, and A. Bhattacharjee, "Measures of quasisymmetry for stellarators," *Journal of Plasma Physics* 88, 905880109 (2022).

14. **E. J. Paul**, S. R. Hudson, and P. Helander, "Heat conduction in an irregular magnetic field: Part II. Heat transport as a measure of the effective non-integrable volume," *Journal of Plasma* Physics 88, 905880107 (2022).

13. **R. Nies**, **E. J. Paul**, S. R. Hudson, and A. Bhattacharjee, "Adjoint methods for quasisymmetry of vacuum fields on a surface," *Journal of Plasma Physics* 88, 905880106 (2022).

12. M. Landreman and **E. J. Paul**, "Magnetic fields with precise quasisymmetry," *Physical Review Letters* 128, 035001 (2022). (Editor's Choice)

11. C. Hegna, D. Anderson, …, **E. J. Paul**, and others, "Improving the stellarator through advances in plasma theory," *Nuclear Fusion* 62, 042012 (2022).

10. A. Geraldini, M. Landreman, and **E. J. Paul**, "An adjoint method for determining the sensitivity of island size to magnetic field variations," *Journal of Plasma Physics* 87, 905870302 (2021).

9. **A. Carlton Jones**, **E. J. Paul**, and W. Dorland, "Computing the shape gradient of stellarator coil complexity with respect to the plasma boundary," *Journal of Plasma Physics* 87, 905870222 (2021).

8. **E. J. Paul**, M. Landreman, and T. M. Antonsen, "Gradient-based optimization of 3D MHD equilibria," *Journal of Plasma Physics* 87, 905870214 (2021).

7. W. Sengupta, **E. J. Paul**, H. Weitzner, and A. Bhattacharjee, "Vacuum magnetic fields with exact quasisymmetry near a flux surface. Part 1: Solutions near an axisymmetric surface," *Journal of Plasma Physics* 87, 905870205 (2021).

6. **E. J. Paul**, T. Antonsen, Jr., M. Landreman, and W. A. Cooper, "Adjoint approach to calculating shape gradients for 3D magnetic confinement equilibria. Part 2. Applications," *Journal of Plasma Physics* 86, 905860103 (2020).

5. **E. J. Paul**, I. G. Abel, M. Landreman, and W. Dorland, "An adjoint method for neoclassical stellarator optimization," *Journal of Plasma Physics* 85, 795850501 (2019).

4. T. Antonsen, Jr., **E. J. Paul**, and M. Landreman, "Adjoint approach to calculating shape gradients for 3D magnetic confinement equilibria," *Journal of Plasma Physics* 85, 905850207 (2019). (Editor's Choice)

3. M. Landreman and **E. J. Paul**, "Computing local sensitivity and tolerances for stellarator physics properties using shape gradients," *Nuclear Fusion* 58, 076023 (2018).

2. **E. J. Paul**, M. Landreman, A. Bader, and W. Dorland, "An adjoint method for gradient-based optimization of stellarator coil shapes," *Nuclear Fusion* 58, 076015 (2018).

1. **E. J. Paul**, M. Landreman, F. M. Poli, D. A. Spong, H. M. Smith, and W. Dorland, "Rotation and neoclassical ripple transport in ITER," *Nuclear Fusion* 57, 116044 (2017).

Monographs

L.-M. Imbert-Gerard, E. J. Paul, and A. M. Wright, "An Introduction to Stellarators: From Magnetic Fields to Symmetries and Optimization," *SIAM* (2024).

Invited Seminars (recent)

2. Courant Computational Mathematics and Scientific Computing Seminar – New York, NY, April 2024
1. MIT PFSC Seminar – Cambridge, MA, May 2024

Invited Colloquia

7. University of Greifswald Physics Colloquium – Greifswald, Germany, June 2024
6. Center for Computational Mathematics Colloquium – New York, NY, April 2024
5. U. Wisconsin Plasma Physics Colloquium – Madison, WI, March 2024
4. Cornell Center for Applied Mathematics Colloquium – Ithaca, NY, November 2022
3. University of Iowa Physics Colloquium – Remote, October 2021
2. Columbia University Plasma Physics Colloquium – Remote, September 2021
1. JPP Frontiers of Plasma Physics Colloquium – Remote, August 2020

Invited Conference Presentations

12. Technical Meeting on Energetic Particles – Seville, Spain, March 2025
11. Simons Foundation Mathematical and Physical Sciences Annual Meeting – New York, New York, October 2024
10. International Stellarator and Heliotron Workshop – Hiroshima, Japan, September 2024

9. IMSI Workshop on Computational Challenges and Optimization in Kinetic Plasma Physics – Chicago, Illinois, February 2024
8. Varenna Workshop on the Theory of Fusion Plasmas – Varenna, Italy, September 2022
7. Simons Hidden Symmetries Collaboration Annual Meeting – New York, NY, March 2022
6. International Toki Conference – Remote, November 2021
5. APS Division of Plasma Physics Meeting – Pittsburgh, PA, November 2021
4. Max Planck Princeton Center Workshop – Gottingen, Germany, January 2020
3. APS Division of Plasma Physics Meeting – Fort Lauderdale, FL, October 2019
2. International Stellarator and Heliotron Workshop – Madison, WI, September 2019
1. Sherwood Fusion Theory Conference – Princeton, NJ, April 2019

Institutional Service

- Class of 2026 Applied Physics Undergraduate Advisor
- Co-organizer of Fall 2023 APAM Research Conference
- Committee member for Women and Diversity in Applied Physics and Applied Mathematics (Spring 2023-present)
- Thesis proposal committee member for Todd Elder (Spring 2023) and Yumou Wei (Spring 2023)

External Service

- IAEA Fusion Energy Conference Program Committee (Spring 2025)
- DOE Fusion Energy Sciences Advisory Committee: Decadal Plan Subcommittee member (Spring 2024-present)
- Organizing committee for IPAM Long Program on Multi-Fidelity Methods for Fusion Energy (planned for Spring 2026)
- Editorial Board member for *Plasma Physics and Controlled Fusion* (Summer 2023-present)
- Sherwood Fusion Theory Conference Executive Committee member (Fall 2022-present) and Program Committee member (Spring 2022)
- Theory Coordinating Committee – charter subcommittee member (Fall 2022-present)
- Thesis committee member for Evan Toler (Spring 2023, NYU), Frederick Law (Summer 2023, NYU), Ralf Mackenbach (Fall 2023, TU Eindhoven), Dean Muir (Fall 2024, ANU)
- Session chair at Sherwood Fusion Theory Conference (Spring 2022 and 2023), International Stellarator and Heliotron Workshop (Summer 2022)
- Advisory Board member for *Journal of Plasma Physics* (Fall 2019-Summer 2023)
- Reviewer for Plasma Physics and Controlled Fusion, Journal of Plasma Physics, Nuclear Fusion, Physics of Plasmas, Nature Scientific Reports, PRX Energy, and Engineering Optimization
- Reviewer for US Dept. of Energy Fusion Energy Sciences and NSF Plasma Physics Program grant proposals

Public lectures

- Joint ICTP-IAEA College on Plasma Physics, Fall 2022
- Guatemalan Student Congress of Physics and Mathematics, Summer 2022
- PPPL Graduate Summer School, Summer 2021 and 2024
- PPPL Introduction to Fusion Energy and Plasma Physics Course, Summer 2021 and 2023
- Simons-PPPL Summer School, Summer 2019 and 2020

Panel discussions

- Princeton University Wintersession panelist, "Advances Toward Commercial Nuclear Fusion", Spring 2025
- Simons Collaboration on Hidden Symmetries and Fusion Energy – panelist on connections between mathematics and physics, Spring 2023
- APS DPP Women in Plasma Physics – panelist on postdoc positions, Spring 2021

Research mentorship

- *Postdocs*: Antoine Baillod (Summer 2023-present), Alexey Knyazev (Fall 2023-present)
- *Ph.D. students*: Amelia Chambliss (Spring 2023-present, DOE CSGF recipient), Abdullah Hyder (Spring 2023-present), Rohan Lopez (Fall 2023-present, NSF GRFP recipient), Alexa Lachmann (Fall 2023-present), Avigdor Veksler (Fall 2024-present), John Labbatte (Fall 2024-present), Shreyas Seethalla (Fall 2024-present), Brandon Lee (Fall 2024-present), Sam Freiberger (Fall 2023-Spring 2024), Frank Fu (co-advisor w/ A. Bhattacharjee, Fall 2023-present), Richard Nies (co-advisor w/ A. Bhattacharjee, Fall 2020-Spring 2022)
- *Masters students*: Xueyi Bu (Summer 2023-Fall 2024, now Amazon)
- *Bridge to Ph.D. students*: Mohammed Haque (Summer 2023-present)
- *Undergraduate students*: Bill Fei (Fall 2024-present), Sanjar Zaman (Fall 2024-present), Henri Yoon (Summer 2024-present), Maria Garmonina (Summer 2024), Analisa Wood (Summer 2024), Ekene Ezeunala (Summer 2024), Grace Rawlinson (Summer 2023-Spring 2024, now U. Chicago), Siwanta Thapa (Summer 2023-Fall 2023, now CU MS), Somin Lee (Summer 2023), Alexander Ireland (Summer 2022-Spring 2023), Daniel Alex (Fall 2021-Spring 2022), Brandon Lee (Spring 2021-Summer 2022, then Fulbright Fellow and Princeton Ph.D. student), Arthur Carlton-Jones (Summer 2019-Spring 2021, now UMD Ph.D. student), Ben Cha (Fall 2018, now U. Waterloo)