

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: 10, Citations: 313 (Jan. 13, 2023)]

Undergraduate students under my primary supervision

Graduate students under my primary supervision

22. Y. Maiko, R. McDermott, and others including **E. J. Paul**, “Transport and Confinement Physics,” *submitted to Nuclear Fusion* (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," *submitted to SIAM* (2024).

Invited Colloquia

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

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

Funding Awards

- “Modeling fast ion-mode interactions toward a stellarator fusion power plant,” single PI through DOE Early Career Research Program, 2023-2028, \$875k
- “Physics and Engineering Metrics for Stellarator-Based Fusion Pilot Plant Concepts,” subcontract to Columbia through PPPL Laboratory Directed Research and Development, 2023-2025, \$367k
- “High-fidelity Digital Models for Fusion Pilot Plant Design,” institutional PI for Columbia through DOE FES SCIDAC program (led by PPPL), 2023-2027, \$557k
- “HiFiStell: High-Fidelity Simulations for Stellarators,” institutional PI for Columbia through DOE FES SCIDAC program (led by Princeton), 2023-2027, \$1.2M
- “Using permanent magnets for near perfect quasi-symmetry in a stellarator,” single PI through Simons Target Grants in Mathematical and Physical Sciences program, 2023-2024, \$135k
- “Hidden Symmetries and Fusion Energy,” institutional co-PI through Simons Collaborations in Mathematical and Physical Sciences program, 2023-2025, \$270k
- XSEDE Educational Grant, co-PI for Summer School on Stellarator Optimization, 2020, 60,000 SUs

Institutional Service

- 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)
- Thesis committee member for Todd Elder (Fall 2023)

External Service

- 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)
- 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-present)
- 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
- PPPL Introduction to Fusion Energy and Plasma Physics Course, Summer 2021 and 2023
- Simons-PPPL Summer School, Summer 2019 and 2020

Panel discussions

- 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), Sam Freiberg (Fall 2023-present), Richard Nies (co-advisor w/ A. Bhattacharjee, Fall 2020-Spring 2022)
- *Masters students*: Xueyi Bu (Summer 2023-present)
- *Bridge to Ph.D. students*: Mohammed Haque (Summer 2023-present)
- *Undergraduate students*: Grace Rawlinson (Summer 2023-present), Siwanta Thapa (Summer 2023-present), Somin Lee (Summer 2023), Alexander Ireland (Summer 2022-Spring 2023), Daniel Alex (Fall 2021-Spring 2022), Brandon Lee (Spring 2021-Summer 2022, now 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)