ZACHARY HILLIARD

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EDUCATION

Ph.D., Mathematics, *Washington State University (WSU).* *2020*

Advisor: Prof. Lynn Schreyer.

Thesis: *Generalizing the Cahn-Hilliard Equation with Applications in Migration Modeling*

Bachelor of Science, Mechanical Engineering, *WSU.* *2014*

Associate of Arts and Sciences, *Columbia Basin College* *2012*

PUBLICATIONS

1) M. Peszynska, **Z. Hilliard**, and N. Vohra, **Coupled flow and energy models with phase change in permafrost from pore- to Darcy scale: Modeling and approximation**, *J. of Computational and Applied Mathematics, 2024*, 450, 115964.
2) **Z. Hilliard**, M.T. Evans and M. Peszynska **Modeling flow and deformation in porous media from pore-scale to the Darcy-scale**, *Results in Applied Mathematics , 2024*, v22, 100448.
3) L. Schreyer and **Z. Hilliard**, **Derivation of generalized Cahn-Hilliard equation for two-phase flow in porous media using hybrid mixture theory**, *Advances in Water Resources, 2021*, 149, 104839.
4) L. Schreyer, N. Voulgarakis, **Z. Hilliard**, S. Lapin and L. Cobb, **Modeling refugee movement based on a continuum mechanics phase-field approach of porous media**. *SIAM J. Appl. Math, 2021*, 81 (5), 2061-2082.
5) **Z. Hilliard**, **Generalizing the Cahn-Hilliard equation with applications in migration modeling**. *PhD thesis, Washington State University, 2020*, https://hdl.handle.net/2376/111097
6) S. Lee, B. VanderVeer, P. Hrma, **Z. Hilliard**, J. Heilman-Moore, C. Bonham, R. Pokorny, D. Dixon, M. Schweiger and A. Kruger, **Effects of heating rate, quartz particle size, viscosity, and form of glass additives on high-level waste melter feed volume expansion**. *J. American Ceramic Society, 2016*, 100 (2), 583-591.
7) **Z. Hilliard** and P. Hrma, **A method for determining bulk density, material density, and porosity of melter feed during nuclear waste vitrification**. *J. American Ceramic Society, 2015*, 99 (1), 98-105.
8) R. Pokorny, **Z. Hilliard**, D. Dixon, M. Schweiger, D. Guillen, A. Kruger and P. Hrma, **One-dimensional cold cap model for melters with bubblers**. *J. American Ceramic Society, 2015*, 98 (10), 3112-3118.

AWARDS

Distinguished Poster Award *2022*

My poster was recognized at the 1st Annual OHSU/OSU Postdoctoral Research Symposium in November of 2020.

Researcher of the Month *2019*

Recognition by the Western region of the National Association of Graduate-Professional Students (W-NAGPS) in March of 2019.

EXPERIENCE

Research Interests

· Partial differential equations · Finite element methods · Nonlinear optimization · Numerical analysis · Time-stepping methods · Upscaling methods

Assistant Professor of Applied Math, Regent University *2024 — Present*

· Research focused on FEMs applied to particle assemblies that model porous media
· Teaching mathematics courses

Postdoctoral Scholar, Oregon State University *2022 — 2023*

· Research focused on upscaling data from pore-scale fluid simulations to estimate Darcy conductivity and use this estimated data in Darcy-scale simulations for poroelasticity and heat transfer.
· Teaching courses such as Advanced Calculus, Introduction to Numerical Analysis, and Numerical Linear Algebra

Upper School Math Instructor at Grove Christian School *2020 — 2022*

· Taught courses in math and science.

Courtesy Postdoctoral Research Associate, Washington State University *2020 — 2021*

· Continued research from my PhD on the Cahn-Hilliard equation.

Intern, Pacific Northwest National Laboratory *2018*

· Parameter estimation for various models quantifying the effects of feed composition on glass melt rate.

Teaching Assistant, Washington State University *2015 — 2020*

· Taught recitation sections for introductory calculus.
· Tutored at the Math Learning Center
· Taught sections of vector calculus and trigonometry.
· Lead instructor for introductory partial differential equations.

Research Assistant, Washington State University Tri-Cities *2014 — 2015*

· Research included small-scale energy harvesting using Piezo-Electrics.
· I transferred from working on my Masters in Mechanical Engineering to Mathematics due to where my interests lay at that time.

Intern, Pacific Northwest National Laboratory *2011 — 2016*

· Parameter estimation for models related to glass melt.
· Developed a Matlab application to estimate the porosity of feed undergoing vitrification using image analysis.
· Designed and reverse engineered various parts in radioactive source transport systems.
· Designed a calorimeter for a solar concentrator capable of melting steel.
· Ran experiments and collected data on radiation monitors.

TEACHING

Regent University

- MATH 102 – College Algebra
- MATH 164 – Pre-Calculus
- MATH 440 – History of Mathematics

Oregon State University

- MTH 311 – Advanced Calculus I
- MTH 351 – Introduction to Numerical Analysis
- MTH 405 – Reading course on Functional Analysis
- MTH 451 – Numerical Linear Algebra

- MTH 481/581 – Applied Differential Equations

Grove Christian School

- Physics
- Calculus
- Advanced Algebra
- Algebra II
- Algebra I
- Math 6

Washington State University

- MATH 440/540 – Applied Math I: PDEs
- MATH 273 – Vector Calculus
- MATH 108 – Trigonometry
- MATH 172L – Calculus II recitation
- MATH 171L – Calculus I recitation

PRESENTATIONS AND CONFERENCES

1) SIAM PNW23 (invited talk), *Using DEM and upscaling to study poroelasticity at the Darcy scale*, Zachary Hilliard, Matt Evans, Malgorzata Peszynska, and Noren Vorha, *Western Washington University*, October 2023
2) SIAM GS23 (invited talk), *Poroelasticity from DEM at pore-scale to nonlinear Biot at Darcy scale*, Matt Evans, Zachary Hilliard and Malgorzata Peszynska, *Bergen, Norway*, June 2023
3) 1st Annual OHSU/OSU Postdoctoral Symposium (poster), *Using a Cahn-Hilliard equation to model mammal migration*, Zachary Hilliard, *Oregon State University*, November 2022.
4) Women in Scientific Computing on Complex Physical and Biological Systems (poster), *Using a Cahn-Hilliard equation to model mammal migration*, Zachary Hilliard, *University of Florida*, October 2022.
5) Joint Math Meetings (contributed talk), *A practical implementation for solving an anisotropic Cahn-Hilliard equation*, Zachary Hilliard, Lynn Schreyer and Nikos Voulgarakis, *Denver, Colorado*, January 2020.
6) Joint Math Meetings (contributed talk), *An anisotropic Cahn-Hilliard equation with variable mobility and gravity potential*, Zachary Hilliard, Lynn Schreyer and Nikos Voulgarakis, *Denver, Colorado*, January 2020.
7) 2nd Biennial Meeting of the SIAM Pacific Northwest Section (contributed talk), *An anisotropic Cahn-Hilliard equation with variable mobility and gravity potential*, Zachary Hilliard, Lynn Schreyer, Nikos Voulgarakis and Sergey Lapin, *Seattle University*, October 2019.
8) CBMS Conference:The Cahn-Hilliard Equation: Recent Advances and Applications (poster), *The Cahn-Hilliard equation in migration modeling*, Zachary Hilliard, Lynn Schreyer, Nikos Voulgarakis and Sergey Lapin, *Burns, Tennessee*, May 2019.
9) 6th Annual Cascade RAIN Meeting (attended), *University of Washington Bothell*, April 2019.
10) 2018 SIAM Annual Meeting (contributed talk), *Numerical analysis of a generalized Cahn-Hilliard equation with applications in porous media*, Zachary Hilliard, Lynn Schreyer, Nikos Voulgarakis and Sergey Lapin, *Portland, Oregon*, July 2018.
11) 1st Biennial Meeting of the SIAM Pacific Northwest Section (poster), *A numerical exploration of the Cahn-Hilliard equation*, Zachary Hilliard, Lynn Schreyer, Nikos Voulgarakis and Sergey Lapin, *Oregon State University*, October 2017.
12) AMS Spring Western Sectional Meeting (attended), *Washington State University*, April 2017.
13) 2014 MRS Fall Meeting (contributed talk), *The void fraction of melter feed during nuclear waste glass vitrification*, Zachary Hilliard and Pavel Hrma, *Boston, Massachusetts*, November 2014.

SKILLS

Programming languages

MATLAB (expert), C/C++ (advanced), Python (advanced).

SOFTWARE

This is a list of the open source software that I have contributed to and used in my research.

1) CellGeometry

- C++ library for manipulating 3-dimensional cell/voxel arrays
- `https://github.com/zachhill222/CellGeometry.git`
- Developers: Zachary Hilliard

TRAVEL AWARDS

1) Early career SIAM travel award to attend SIAM GS23; *2023*.
2) Funding from NSF award 2212165; Women in Scientific Computing on Complex Physical and Biological Systems; travel support; *2022*.
3) Funding from NSF award 1836403; CBMS Conference: The Cahn-Hilliard Equation: Recent Advances and Applications; full support; *2019*.
4) Annual Cascade RAIN Meeting, University of Washington Bothell; travel support, *2019*.

SERVICE

Calculus I lead TA *2020*

- Created quizzes for TAs to use in recitation
- Provided general assistance to new TAs

GQE Analysis Review *2018*

- Taught the analysis review for graduate students yet to pass the Graduate Qualifying Exam at WSU.

Referee for Journals

- *Partial Differential Equations in Applied Mathematics* *2024*
- *PUMP Journal of Undergraduate Research* *2023*
- *Scientific Reports* *2022*