

# ZACHARY HILLIARD

509-713-3617 ♦ zhilliard@regent.edu

<https://github.com/zachhill222> ♦ ORCID: 0000-0003-1390-0510

## EDUCATION

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**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

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- 1) 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.
- 2) 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.
- 3) **Z. Hilliard**, **Generalizing the Cahn-Hilliard equation with applications in migration modeling**. *PhD thesis, Washington State University, 2020*, <https://hdl.handle.net/2376/111097>
- 4) 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.
- 5) **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.
- 6) 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

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**Distinguished Poster Award** 2022

My poster was recognized at the 1<sup>st</sup> 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

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### 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

- Teaching courses such as Pre-Calculus and History of Mathematics

**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

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### 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**

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- 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) 1<sup>st</sup> 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) 2<sup>nd</sup> 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) 6<sup>th</sup> 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) 1<sup>st</sup> 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**

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### **Programming languages**

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

## **SOFTWARE**

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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/zachhill1222/CellGeometry.git>
- Developers: Zachary Hilliard

## TRAVEL AWARDS

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- 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

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### 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

- *PUMP Journal of Undergraduate Research*
- *Scientific Reports*

*2023*

*2022*