**Shukai Du** **Curriculum Vitae**

Assistant Professor
Department of Mathematics
Syracuse University

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## RESEARCH INTERESTS

- Finite element and discontinuous Galerkin methods
- Scientific machine learning and data-driven methods
- Computational inverse and ill-posed problems
- Numerical methods for radiative transfer
- Electromagnetic and elastic/viscoelastic waves

## PROFESSIONAL EXPERIENCE

Syracuse University

- Assistant Professor — Oct 2024 – now

University of Wisconsin-Madison

- Visiting Assistant Professor — Sep 2020 – Sep 2024

University of Minnesota-Twin Cities

- Visiting Doctoral Student — Sep 2019 – June 2020

## EDUCATION

**University of Delaware**

- **Ph.D** in **Applied Mathematics** — 2020
  Advisor: Dr. Francisco-Javier Sayas
  Thesis: Generalized projection-based error analysis of hybridizable discontinuous Galerkin methods

**Wuhan University**

- M.S. in Computational Mathematics — 2015
- B.S. in Pure Mathematics — 2012

## PUBLICATIONS

### Submitted

16. J. L. Torchinsky, **S. Du**, S. N. Stechmann. Angular-spatical hp-adaptivity for radiative transfer with discontinuous Galerkin spectral element methods.

### Peer-reviewed

15. **S. Du**, and S. N. Stechmann. Element learning: a systematic approach of accelerating finite element-type methods via machine learning, with applications to radiative transfer. *J. Comp. Math. (2024).*
DOI: 10.4208/jcm.2407-m2024-0047
14. **S. Du**, and S. N. Stechmann. Inverse radiative transfer with goal-oriented hp-adaptive mesh refinement: adaptive-mesh inversion. *Inverse Probl. 39 (2023), no. 11.*
DOI: 10.1088/1361-6420/acf785

13. B. Cockburn, **S. Du**, M. A. Sánchez. A priori error analysis of new semidiscrete, Hamiltonian HDG methods for the time-dependent Maxwell's equations. *ESAIM: M2AN 57 (2023), no.4, 2097-2129*.
DOI: 10.1051/m2an/2023048
12. **S. Du**, and S. N. Stechmann. Fast, low-memory numerical methods for radiative transfer via hp-adaptive mesh refinement. *J. Comput. Phys. 480 (2023)*.
DOI: 10.1016/j.jcp.2023.112021
11. **S. Du**, and S. N. Stechmann. A universal predictor-corrector approach for minimizing artifacts due to mesh refinement. *J. Adv. Model. Earth Syst. 15 (2023)*.
DOI: 10.1029/2023MS003688
10. B. Cockburn, **S. Du**, M. A. Sánchez. Combining finite element space-discretization with symplectic time-marching schemes for linear hamiltonian systems. *Front. Appl. Math. Stat. 9 (2023)*.
DOI: 10.3389/fams.2023.1165371
9. M. A. Sánchez, **S. Du**, B. Cockburn, N.-C. Nguyen, J. Peraire. Symplectic Hamiltonian finite element methods for electromagnetics. *Comput. Methods Appl. Mech. Engrg. 396 (2022)*.
DOI: 10.1016/j.cma.2022.114969
8. B. Cockburn, M. A. Sánchez, **S. Du**. Discontinuous Galerkin methods with time-operators in their numerical traces for time-dependent electromagnetics. *Comput. Meth. Appl. Math. (2022)*.
DOI: 10.1515/cmam-2021-0215
7. **S. Du**, and F.-J. Sayas. A note on devising HDG+ projections on polyhedral elements. *Math. Comp. 90 (2021), 65-79.*
DOI: 10.1090/mcom/3573
6. **S. Du**. HDG methods for Stokes equation based on strong symmetric stress formulations. *J. Sci. Comput. 85, 8 (2020)*.
DOI: 10.1007/s10915-020-01309-7
5. **S. Du**, and F.-J. Sayas. A unified error analysis of hybridizable discontinuous Galerkin methods for the static Maxwell equations. *SIAM J. Numer. Anal. 58 (2020), no. 2, 1367–1391*.
DOI: 10.1137/19M1290966
4. **S. Du**, and F.-J. Sayas. New analytical tools for HDG in elasticity, with applications to elastodynamics. *Math. Comp. 89 (2020), 1745-1782.*
DOI: 10.1090/mcom/3499
3. **S. Du**, and N. Du. A factorization of least-squares projection schemes for ill-posed problems. *Comput. Meth. Appl. Math. 20 (2020), no. 4, 783-798.*
DOI: 10.1515/cmam-2019-0173
2. T.S. Brown, **S. Du**, H. Eruslu, and F.-J. Sayas. Analysis of models for viscoelastic wave propagation. *Appl. Math. Nonlin. Sci. 3 (2018), no. 1, 55-96.*
DOI: 10.21042/AMNS.2018.1.00006

**Books**

1. **S. Du**, and F.-J. Sayas. An invitation to the theory of the Hybridizable Discontinuous Galerkin Method. *SpringerBriefs in Mathematics (2019)*.
DOI: 10.1007/978-3-030-27230-2

## GRANTS

- NSF (DMS–2324368): Breaking the 1D Barrier in Radiative Transfer: Fast, Low-Memory Numerical Methods for Enabling Inverse Problems and Machine Learning Emulators. Senior personnel. $498,832 total, $350,000 at UW (2023–2026).
- NSF (AGS–2326631): Convective Processes in the Tropics Across Scales. Senior personnel. $768,471 total, $471,155 at UW (2024–2026).

## PRESENTATION

### Invited talks

31. Forward and inverse computation for radiative transfer via hp-adaptive mesh refinements
14th AIMS Conference, Abu Duhabi — Dec 2024
30. Inverse radiative transfer via goal-oriented hp-adaptive mesh refinement
14th AIMS Conference, Abu Duhabi — Dec 2024
29. Element learning: accelerating finite element-type methods via operator learning with cost-effective training
*SIAM sectional meeting, Rochester Institute of Technology* — Nov 2024
28. Forward and inverse computation for radiative transfer via hp-adaptive mesh refinement and machine learning acceleration
*Analysis seminar, Binghamton University* — Oct 2024
27. Element learning: a systematic approach of accelerating finite element-type methods via machine learning
*CCAM seminar, Purdue University* — Mar 2024
26. Element learning: a systematic approach of accelerating finite element-type methods via machine learning
*Analysis and Data Science Seminar, SUNY at Albany* — Feb 2024
25. Element learning: a systematic approach of accelerating finite element-type methods via machine learning
*Math Department Colloquium, Syracuse University* — Jan 2024
24. Element learning: a systematic approach of accelerating finite element-type methods via machine learning
*Math Department Colloquium, Chinese University of Hong Kong* — Dec 2023
23. Element learning: a systematic approach of accelerating finite element-type methods, with applications to radiative transfer
*University of Electronic Science and Technology of China* — Nov 2023
22. Element learning: a systematic approach of accelerating finite element-type methods via machine learning, with applications to radiative transfer
*Scientific Computing Seminars, University of Houston* — Nov 2023
21. Element learning: a systematic approach of accelerating finite element-type methods via machine learning, with applications to radiative transfer
*Applied Math seminar, University of Louisiana at Lafayette* — Oct 2023
20. Element learning: a systematic approach of accelerating finite element-type methods, with applications to radiative transfer
*Numerical analysis and PDE seminar, University of Delaware* — Sep 2023
19. Energy-conserving discontinuous Galerkin methods with time-operators in their traces for time-dependent electromagnetics
*17th UCNCCM, Albuquerque, NM* — July 2023

18. Fast, low-memory methods for radiative transfer through hp-adaptive mesh refinement
*13th AIMS Conference, Wilmington, NC* June 2023
17. Unified analysis of HDG methods for the static Maxwell equations
*CILAMCE-PANACM 2021, Brazil* Nov 2021
16. Generalized projection-based error analysis of hybridizable discontinuous Galerkin (HDG) methods
*CEDYA2021, Spain* June 2021
15. Projection-based analysis of hybridizable discontinuous Galerkin (HDG) methods
*Wenbo Li Prize Talk, U of Delaware* Feb 2020
14. Unified analysis of HDG methods for the static Maxwell equations
*SIAM CSE2021, Virtual Meeting* Mar 2021
13. New analysis techniques of HDG+ method
*SIAM Sectional Meeting, Iowa State U* Oct 2019
12. Uniform-in-time optimal convergent HDG method for transient elastic waves with strong symmetric stress formulation
*WAVES2019, TU Wien, Vienna* Aug 2019
11. Hybridizable Discontinuous Galerkin schemes for elastic waves
*ICIAM2019, Valencia* July 2019
10. HDG for transient elastic waves
*WONAPDE2019, U of Concepcion* Jan 2019

**Contributed talks**

9. Element learning: accelerating finite element methods via operator learning
FEM Circus, U of Notre Dame Oct 2023
8. Three-dimensional radiative transfer: fast, low-memory numerical methods
*Collective Madison Meeting, Madison, WI* Aug 2022
7. Projection-based analysis of HDG methods with reduced stabilization
*DelMar Num Day 2019, U of Maryland* May 2019
6. Projection-based error analysis of HDG methods for transient elastic waves
*FEM Circus, U of Delaware* Nov 2018
5. Devising a tailored projection for a new HDG method in linear elasticity
*FEM Circus, U of Tennessee* Mar 2018
4. A new HDG projection and its applications
*Mid-Atlantic Numerical Analysis Day, Temple U* Nov 2017

**Poster presentation**

3. Fast, low-memory numerical methods for radiative transfer: forward and inverse problems
*New Trends in Computational and Data Sciences, Caltech* Dec 2022
2. Hybridizable Discontinuous Galerkin methods in transient elastodynamics
*FACM2018, New Jersey Institute of Technology* Aug 2018
1. Building a computational code for 3D viscoelastic wave simulation
*Mid-Atlantic Numerical Analysis Day, Temple U* Nov 2016

## TEACHING

### Instructor

- Multivariable calculus (MAT397) at Syracuse University — Spring 2025
- Linear Algebra and Differential Equations (Math320) at UW-Madison — Spring 2023

### Teaching Assistant

- Analytic Geometry and Calculus C (Math243) — 2016&2017 Fall
- Analytic Geometry and Calculus B (Math242) — 2017 Spring
- Calculus I (Math221) — 2018 Spring
- Review of Advanced Mathematical Problems
  (summer courses offered to incoming graduate students) — 2018 Fall

## MENTORING ACTIVITIES

### Graduate mentorship

- Jason Torchinsky (co-mentored with Samuel N. Stechmann) — 2022 – 2023

### Undergraduate mentorship

- WISCERS project at the University of Wisconsin-Madison — 2023
  – a research-focused mentorship program for undergraduate students
- GEMS summer research project at the University of Delaware — Fall 2016

## JOURNAL REFEREE

Journal of Scientific Computing
SIAM Journal on Scientific Computing
SIAM Multiscale Modelling and Simulation
ESAIM: Mathematical Modelling and Numerical Analysis
Computers and Mathematics with Applications
Frontiers in Applied Mathematics and Statistics

## AWARDS AND HONORS

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|---|---|
| Wenbo Li Prize | 2020 |
| University Doctoral Fellowship Award at the University of Delaware | 2019 |
| ICIAM2019 travel grant | 2019 |
| Graduate Enrichment Fellowship at the University of Delaware | 2018 |
| GEMS project fund at the University of Delaware | Summer 2016 |
| National Scholarship for Graduate Students of China | 2013 |
| People's Scholarship of Wuhan University | 2011 |
| Outstanding Student of Wuhan University | 2009 – 2011 |

## SERVICES

Mentor for SIAM Virtual Resume Building Workshop — Oct 2024

## CODING PROJECTS

Fast, low-memory methods for radiative transfer — 2020 – 2022

- Build a cell-based structured adaptive mesh refinement (AMR) data structure
- Implement discontinuous Galerkin (DG) methods with $hp$-adaptivity for the full radiative transfer equation

Hybridizable Discontinuous Galerkin (HDG) methods 2016 – 2020
(based on HDG3D library: github.com/team-pancho/HDG3D)

- Build Matlab codes of high order HDG methods on computing cluster for transient elastic/viscoelastic waves and Maxwell equations
- Write documentation with detailed implementation procedures for HDG methods for Maxwell equations

Finite Element Method (FEM) 2016
(based on Team Pancho FEM library: team-pancho.github.io)

- Build Matlab codes of high order FEM methods on computing cluster for simulation of viscoelastic waves.

Multiscale modeling 2013 – 2015

- Implement algorithms to calculate Cauchy stress tensor based on micro-scale molecular dynamics information

**COMPUTER SKILLS**

*Theory*
Data Structures • Algorithm • Object Oriented Programming
*Languages & Software*
Matlab • Python • C • C++ • Fortran • openMPI • LISP • Linux Shell

Last update: June 8, 2025