

# SEUNG WHAN CHUNG

Postdoctoral Researcher ◊ Material Engineering Division ◊ Lawrence Livermore National Laboratory

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## EDUCATION

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| <b>University of Illinois at Urbana-Champaign</b>               | <i>January 2017 - August 2021</i>  |
| Ph. D in Theoretical and Applied Mechanics                      | GPA: 4.0/4.0                       |
| <b>University of Illinois at Urbana-Champaign</b>               | <i>August 2014 - December 2016</i> |
| M. S in Theoretical and Applied Mechanics                       | GPA: 3.88/4.0                      |
| <b>Seoul National University</b>                                | <i>March 2008 - February 2014</i>  |
| B. S. in Mechanical and Aerospace Engineering (Summa cum laude) | GPA: 3.96/4.3                      |

## RESEARCH

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- **Lawrence Livermore National Laboratory** January 2023 - Present  
*Postdoctoral Staff Member* Livermore, CA
  - Developed a scalable reduced order model with discontinuous Galerkin domain decomposition
  - Orchestrated the development of `pylibROM`, python interface for the library of reduced order modeling
  - Advised and mentored two summer student interns (Ping-Hsuan Tsai, Seung-Won Suh)
- **University of Texas at Austin** September 2021 - December 2022  
*Postdoctoral Fellow* (with Prof. R. Moser, Prof. L. Raja, Dr. T. Oliver) Austin, TX
  - Uncertainty quantification of electron-argon collision cross sections via Bayesian inference
  - Physics-based reduced-modeling of inductively-coupled argon plasma torch
  - Developed a discontinuous-Galerkin HPC solver for large-scale non-equilibrium plasma simulations
- **University of Illinois at Urbana-Champaign** January 2015 - August 2021  
*Graduate Researcher* (with Prof. Jonathan Freund) Urbana, IL
  - Developed multi-point penalty-based optimization framework for chaotic turbulent flows.
  - Implemented and validated turbulence statistics and sound radiation of a compressible Mach-1.3 jet.
- **Sandia National Laboratories** January 2017 - May 2017  
*Student Intern* (with Dr. Stephen D. Bond, Dr. Eric C. Cyr) Albuquerque, NM
  - Developed a novel regular gradient computing method for chaotic particle plasma simulations.
  - Demonstrated gradient computation for Debye shielding response and sheath edge formation.

## SKILLS

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| <b>Computer Languages</b>    | Python, C++, MATLAB, Fortran, pybind11                               |
| <b>Parallel Programming</b>  | MPI  |
| <b>Simulation Libraries</b>  | <a href="#">MFEM</a> , <a href="#">libROM</a> , <a href="#">Gmsh</a> |
| <b>Scripting</b>             | Python, Bash, Flux   |
| <b>Version Control</b>       | Git, Docker  |
| <b>Documentation</b>         | L <sup>A</sup> T <sub>E</sub> X, Vi/Vim, Mendeley                    |
| <b>Visualization and I/O</b> | PLOT3D, HDF5, Paraview   |
| <b>Presentation</b>          | Beamer, Keynote, Adobe Illustrator/Premiere                          |

## PUBLICATIONS

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- S. W. Chung**, Y. Choi, P. Roy, T. Roy, T. Moore, T. Lin & S. E. Baker, “Train small, model big: scalable physics simulators via reduced order modeling and domain decomposition,” *In preparation*.
- S. W. Chung**, T. A. Oliver, L. Raja & R. D. Moser, “Characterization of uncertainties in electron-argon collision cross sections under statistical principles,” *Plasma Sources Science and Technology*, submitted, (2023).
- S. W. Chung** & J. B. Freund, “An optimization method for chaotic turbulent flows,” *Journal of Computational Physics*, **457**, (2022).
- S. W. Chung**, S. D. Bond, E. C. Cyr, & J. B. Freund, “Regular sensitivity computation avoiding chaotic effects in particle-in-cell plasma methods,” *Journal of Computational Physics*, **400** (2020).

## CONFERENCE TALKS

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- S. W. Chung**, Y. Choi, P. Roy, T. Roy, T. Moore, T. Lin & S. E. Baker, “Scalable physics-guided data-driven component model reduction for Stokes flow,” *NeurIPS 2023 Workshop on the Machine Learning and the Physical Sciences*, submitted, (2023).
- P.-H. Tsai, **S. W. Chung**, D. Ghosh, J. Loffeld, Y. Choi & J. L. Belof, “Accelerating Kinetic Simulations of Electrostatic Plasmas with Reduced-Order Modeling,” *NeurIPS 2023 Workshop on the Machine Learning and the Physical Sciences*, submitted, (2023).
- S. W. Suh, **S. W. Chung**, T. Bremer & Y. Choi, “Accelerating Flow Simulations using Online Dynamic Mode Decomposition,” *NeurIPS 2023 Workshop on the Machine Learning and the Physical Sciences*, submitted, (2023).
- S. W. Chung** & J. B. Freund. ”Finding an optimal flow control with multi-point penalty method,” *Bulletin of the American Physical Society*, **67** (2022).
- S. W. Chung**, T. A. Oliver, L. L. Raja & R. D. Moser, “Characterization of uncertainties in electron-argon collision cross sections under statistical principles,” *Bulletin of the American Physical Society*, **67** (2022).
- S. W. Chung** & J. B. Freund. ”Multi-point penalty-based optimization for optimal control of chaotic turbulent flow,” *Bulletin of the American Physical Society*, **66** (2021).
- S. W. Chung** & J. B. Freund, “Multi-point augmented Lagrangian optimization for chaotic flows,” *SIAM Conference on Computational Science and Engineering*, (2021).
- S. W. Chung** & J. B. Freund. ”Multi-point augmented Lagrangian optimization for chaotic flows,” *Bulletin of the American Physical Society*, **65** (2020).
- S. W. Chung** & J. B. Freund, “Adjoint-based analysis of controllability of turbulent jet noise,” *Bulletin of the American Physical Society*, **64** (2019).
- S. W. Chung**, S. D. Bond, E. C. Cyr, & J. B. Freund, “Regular sensitivity computation avoiding chaotic effects in particle-in-cell plasma methods,” *International Conference on Numerical Simulation of Plasmas*, (2019).
- S. W. Chung**, S. D. Bond, E. C. Cyr, & J. B. Freund, “Sensitivity analysis in particle-in-cell methods,” *SIAM Conference on Computational Science and Engineering*, (2019).
- S. W. Chung**, R. Vishnampet, D. Bodony, & J. B. Freund, “Adjoint-based sensitivity of jet noise to near-nozzle forcing,” *Bulletin of the American Physical Society*, **62** (2017).

## INVITED TALKS

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J. B. Freund & **S. W. Chung**, Lawrence Livermore National Laboratory, (2021).

**S. W. Chung**, *Fluid Mechanics Seminar*, University of Illinois at Urbana-Champaign, (2020).

**S. W. Chung**, Sandia National Laboratories, (2017).

## JOURNAL REFEREE

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Journal of Fluid Mechanics (2022-present)

## RESEARCH TOOLS DEVELOPED

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### ◦ **scaleupROM: Scalable Physics-guided Reduced Order Model**

*Available upon request*

- A scalable reduced order model for linear PDE systems with discontinuous Galerkin domain decomposition, implemented upon **MFEM** and **libROM** framework
- Developed and demonstrated the framework for Poisson and Stokes flow equation

### ◦ **pylibROM: python interface for libROM**

<https://github.com/LLNL/pylibROM>

- Implemented efficient python interface for **libROM** classes
- Demonstrated examples of DMD and projection-based ROM for various physics systems

### ◦ **libROM: Library for Reduced Order Models**

<https://www.librom.net/>

- Implemented and maintained Docker container and CI workflow

### ◦ **TPS: Torch Plasma Simulator**

*with M. Bolinches, T. Oliver, K. Schulz, R. Moser*

<https://github.com/pecos/tps>

- A discontinuous-Galerkin multi-physics application to support a plasma torch prediction, implemented upon a gpu-enabled finite-element library (**MFEM**)
- Formulated and implemented a two-temperature non-equilibrium reacting flow solver

### ◦ **torch1d: one-dimensional reduced-model for inductively-coupled plasma torch**

*with T. Oliver, R. Moser*

<https://github.com/pecos/torch1d>

- A Python-based finite-difference solver for a one-dimensional reduced torch model
- Supports low-Mach limit formulation for two-temperature non-equilibrium plasma

### ◦ **magudi: Dual-consistent, Discrete-exact Adjoint solver for Compressible Flows**

*with R. Vishnampet, J. B. Freund*

<https://github.com/dreamer2368/magudi>

- A Fortran-based compressible flow solver, equipped with discrete-exact adjoint-based gradient.
- Incorporated a Python-based framework for multi-point penalty-based optimization capability.

### ◦ **adjoint playground: Adjoint, penalty-based optimization for chaotic flow controls**

*with J. B. Freund*

*Available upon request*

- A MATLAB-based penalty-based optimization framework for various chaotic dynamical systems.
- Provides a discrete-exact adjoint gradient for semi-implicit Runge-Kutta 4th-order time integrator.

### ◦ **PASS: Particle Adjoint Sensitivity Sandbox**

*with J. B. Freund*

<https://github.com/dreamer2368/PASS>

- A Fortran-based 1D Particle-in-Cell code for plasma kinetics, with adjoint gradient capability

## TEACHING

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### ◦ TAM 210/211: Statics

*Teaching Assistant*

Spring 2020

University of Illinois at Urbana-Champaign

- Ranked as Excellent in the list of Spring 2020 semester.
- Conducted discussion sessions (1 time/wk) for 27 students.
- Prepared in-depth solution procedures.
- Provided extended office hours: 6 hrs/wk

## AWARDS/FELLOWSHIPS

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### Jeong-Song Fellowship

2014 - 2016

*Jeong-Song Cultural Foundation, Korea*

\$110,000

### Honor Graduation Award

2014

*Seoul National University*

Ranked 5 of 139 (summa cum laude)

### Presidential Science Fellowship

2008 - 2014

*M. B. Lee, the President of Republic of Korea*

\$40,000

## GRADUATE COURSES

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### Fluid Mechanics

Inviscid Flow

Viscous Flow

Instability and Transition

Turbulence

### Computational Methods

Computational Mechanics

Uncertainty Quantification

Asymptotic Method

Mathematical Methods II

### Applied Mechanics

Control System Theory & Design

Solid Mechanics I

Combustion Fundamentals

Non-Newtonian Fluid Mechanics & Rheology