

# SEUNG WHAN CHUNG

Computational Scientist ◊ Center for Applied Scientific Computing ◊ 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** April 2024 - Present  
*Computational Scientist* Livermore, CA
- **Lawrence Livermore National Laboratory** January 2023 - March 2024  
*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 three student interns (Ping-Hsuan Tsai, Seung-Won Suh, Axel Larsson)
- **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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N. A. Petersson, S. Günther & **S. W. Chung**, “A time-parallel multiple-shooting method for large-scale quantum optimal control,” *arXiv preprint*, arXiv:2407.13950, (2024).

D. Chakraborty, **S. W. Chung** & R. Maulik, “Divide And Conquer: Learning Chaotic Dynamical Systems With Multistep Penalty Neural Ordinary Differential Equations,” *arXiv preprint*, arXiv:2407.00568, (2024).

**S. W. Chung**, Y. Choi, P. Roy, T. Moore, T. Roy, T. Lin, D. T. Nguyen, C. Hahn, E. B. Duoss & S. E. Baker, “Train small, model big: scalable physics simulators via reduced order modeling and domain decomposition,” *Computer Methods in Applied Mechanics and Engineering*, **427**, (2024).

**S. W. Chung**, T. A. Oliver, L. Raja & R. D. Moser, “Characterization of uncertainties in electron-argon collision cross sections under statistical principles,” *arXiv preprint*, arXiv:2404.00467, (2024).

**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. Suh, **S. W. Chung** & Y. Choi, “On-the-fly Dynamic Mode Decomposition,” *16th World Congress on Computational Mechanics and 4th Pan American Congress on Computational Mechanics* (2024).

D. Chakraborty, **S. W. Chung** & R. Maulik, “Divide and Conquer: Improved Training of Neural Ordinary Differential Equations Through Time-domain Splitting,” *16th World Congress on Computational Mechanics and 4th Pan American Congress on Computational Mechanics* (2024).

**S. W. Chung**, Y. Choi, P. Roy, T. Roy, T. Moore, T. Lin & S. E. Baker, “Train Small, Model Big: Scalable Robust Physics Simulator via Reduced Order Modeling and Domain Decomposition,” *16th World Congress on Computational Mechanics and 4th Pan American Congress on Computational Mechanics* (2024).

**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* (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* (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* (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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**S. W. Chung**, *FEM@LLNL Seminar*, Lawrence Livermore National Laboratory, (2024).

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**

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

- A data-driven discontinuous Galerkin FEM for general PDE systems based upon **MFEM** and **libROM**
- Developed and demonstrated the framework for various physics

### ◦ **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

### ◦ **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.

- **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
- **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** Spring 2020  
*Teaching Assistant* 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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<b>Jeong-Song Fellowship</b>	2014 - 2016
<i>Jeong-Song Cultural Foundation, Korea</i>	\$110,000
<b>Honor Graduation Award</b>	2014
<i>Seoul National University</i>	Ranked 5 of 139 (summa cum laude)
<b>Presidential Science Fellowship</b>	2008 - 2014
<i>M. B. Lee, the President of Republic of Korea</i>	\$40,000

## GRADUATE COURSES

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<b>Fluid Mechanics</b>	<b>Computational Methods</b>	<b>Applied Mechanics</b>
Inviscid Flow	Computational Mechanics	Control System Theory & Design
Viscous Flow	Uncertainty Quantification	Solid Mechanics I
Instability and Transition	Asymptotic Method	Combustion Fundamentals
Turbulence	Mathematical Methods II	Non-Newtonian Fluid Mechanics & Rheology