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MIT Department of Mechanical Engineering
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Current Academic Position

2024–2025 **Postdoctoral Associate – Massachusetts Institute of Technology**

Education

2018–2024 **Ph.D. in Mechanical Engineering – Massachusetts Institute of Technology**
 Thesis: *Combustion Physics and Inverse Modeling of Energetic Materials*
 Advisor: Professor Sili Deng

2015–2017 **M.S. in Mechanical Engineering – Seoul National University**
 Thesis: *Measurement of Eccentricity Effects on Stability of a High-Speed Shrouded Centrifugal Compressor*
 Advisor: Professor Seung Jin Song

2009–2015 **B.S. in Mechanical and Aerospace Engineering – Seoul National University**
 Thesis: *Optimization Study of Operating Patterns and Effectiveness for a Distributed Energy System*
 Advisor: Professor Seung Jin Song

Research Interests

Energy Energetic materials (propellants and explosives), Metastable intermolecular composites, Nanomaterial synthesis, Carbon-neutral metal combustion, Hydrogen production, Reacting flow dynamics, Multiphase heterogeneous reactions, Multiscale transport phenomena, and Chemical kinetics.

AI Scientific machine learning, PDE discovery, Surrogate modeling, Model inversion, Nonlinear optimization, Bayesian statistics, Sparse sensing, and Digital twins.

Research Experience

07/2024
–Present **Postdoctoral Associate, Massachusetts Institute of Technology**
 Supervisor: Professor Sili Deng

- Scientific machine learning for interpretable and meta-learnable models
- Bayesian approaches for model inversion and uncertainty quantification
- Architected solid propellants towards programmable engine performance
- Modeling heterogeneous reactions on nanocrystals for gas sensing and carbon capture applications
- Carbon-free hydrogen production via metal-water reactions at the ambient temperature

01/2019
–05/2024 **Graduate Research Assistant & MathWorks Fellow, Massachusetts Institute of Technology**
 Ph.D. advisor: Professor Sili Deng

- Theories for multi-phase reacting flow dynamics and flame instability in energetic materials
- *In-situ* observations of combustion dynamics at μm and μs resolutions
- Development of inverse models for quantifying chemical kinetics and thermal properties
- Scientific machine learning for dynamical systems subject to numerical stiffness
- Academic collaborators: Prof. John Wen (U. Waterloo), Dr. Chris Rackauckas (Julia Lab, MIT)

- 09/2017 **Researcher**, *Seoul National University*
 –05/2018 Supervisor: Professor Seung Jin Song
- Secondary cooling flows through a rim seal for a high-efficient gas turbine
 - Development of an axial turbine, a secondary flow system, and an instrumentation system
 - First operator for the newly developed axial turbine
 - Industrial collaborator: Doosan Heavy Industry
- 01/2015 **Graduate Research Assistant**, *Seoul National University*
 –08/2017 M.S. advisor: Professor Seung Jin Song
- Aerodynamic instability in a high-speed shrouded centrifugal compressor
 - Design of an industrial high-speed centrifugal compressor with ~ 200 sensors
 - Experimental study of eccentricity effects on rotating stall and surge
 - Analytical modeling of aerodynamic loss due to film cooling on a turbine blade
 - Academic & industrial collaborators: Korea Aerospace Research Institute and Hanwha Techwin
- 01/2012 **Undergraduate Research Assistant**, *Seoul National University*
 –06/2012 Advisor: Professor Seung Jin Song
- Engineering-policy model and technoeconomic analysis for a distributed energy system
 - Optimization of energy system components and operating patterns
 - Industrial collaborator: Blue Economy Strategy Institute
- 01/2012 **Undergraduate Research Assistant**, *Seoul National University*
 –06/2012 Advisor: Professor Chong Am Kim
- Computational fluid dynamics for flows over an object
 - Design of a wind turbine tower minimizing unsteady wake flow

Journal Publications

co-first authors, * corresponding authors

To appear

- 2025 S. Deng* and **S. Kim**, “Decoding Physics from Combustion Experiments: Quantification of Intrinsic Properties with Uncertainties from Reacting Flow Dynamics”, *Propellants, Explosives, Pyrotechnics*.

In peer review & preprint

- In peer review **S. Kim**, and S. Deng*, “Model Inversion and Uncertainty Quantification for Chemical Kinetics and Thermal Properties from Combustion Waves”, *Journal of Computational Physics*.

Published articles (9 first-authored papers, 1 corresponding-authored paper, and 3 co-authored papers)

- 2025 **S. Kim**, A. Wang, J. Wen, and S. Deng*, “Combustion Waves and Flame Stability in Nanocomposites”, *ACS Nano* (IF: 16.0), ASAP article.
- 2025 S. Deng*, L. Wang, **S. Kim**, and B. Koenig, “Scientific Machine Learning in Combustion for Discovery, Simulation, and Control”, *Proceedings of the Combustion Institute* (IF: 5.2), 41, 105796.
- 2025 B. Koenig#, **S. Kim**#, and S. Deng*, “ChemKANs for Combustion Chemistry Modeling and Acceleration”, *Physical Chemistry Chemical Physics* (IF: 2.9), 27(33), 17313-17330.

- 2025 B. Koenig, **S. Kim**^{*}, and S. Deng^{*}, “LeanKAN: A Parameter-Lean Kolmogorov-Arnold Network Layer with Improved Memory Efficiency and Convergence Behavior”, *Neural Networks* (IF: 6.3), 192, 107883.
- 2024 B. Cha[#], A. Wang[#], **S. Kim**[#], J.-P. Hickey, S. Deng^{*}, and J. Wen^{*}, “Microstructural Thermal Zones in Reaction of Nanoenergetics”, *ACS Applied Materials & Interfaces* (IF: 8.2), 16(48), 66099-66107.
- 2024 **S. Kim**, and S. Deng^{*}, “Learning Reaction-Transport Coupling from Thermal Waves”, *Nature Communications* (IF: 15.7), 15, 9930.
- 2024 B. Koenig[#], **S. Kim**[#], and S. Deng^{*}, “KAN-ODEs: Kolmogorov-Arnold Network Ordinary Differential Equations for Learning Dynamical Systems and Hidden Physics”, *Computer Methods in Applied Mechanics and Engineering* (IF: 7.3), 432(A), 117397.
- 2024 G. Tsai[#], **S. Kim**[#], and S. Deng^{*}, “Thermal Interaction of Inert Additives in Energetic Materials”, *Proceedings of the Combustion Institute* (IF: 5.2), 40, 105459.
- 2023 **S. Kim**, and S. Deng^{*}, “Inference of Chemical Kinetics and Thermodynamic Properties from Constant-Volume Combustion of Energetic Materials”, *Chemical Engineering Journal* (IF: 13.2), 469, 143779.
- 2023 **S. Kim**, A. Johns, J. Wen, and S. Deng^{*}, “Burning Structures and Propagation Mechanisms of Nanothermites”, *Proceedings of the Combustion Institute* (IF: 5.2), 39(3), 3593-3604.
- 2021 **S. Kim**, W. Ji, S. Deng^{*}, Y. Ma, and C. Rackauckas^{*}, “Stiff Neural Ordinary Differential Equations”, *Chaos: An Interdisciplinary Journal of Nonlinear Science* (IF: 3.2), 31, 093122.
- 2019 J. Song, **S. Kim**, T. C. Park, B.-J. Cha, D. H. Lim, J. S. Hong, T. W. Lee, and S. J. Song^{*}, “Non-Axisymmetric Flows and Rotordynamic Forces in an Eccentric Shrouded Centrifugal Compressor – Part 1: Measurement”, *Journal of Engineering for Gas Turbines and Power* (IF: 2.1), 141(11), 111014.
- 2012 S. Oh, Y. Lee, Y. Yoo, J. Kim, **S. Kim**, S. J. Song, H. Kwak^{*}, “A Support Strategy for the Promotion of Photovoltaic Uses for Residential Houses in Korea”, *Energy Policy* (IF: 9.2), 53, 248-256.

Domestic article

- 2013 **S. Kim**, D. H. Jin, G. B. Lee, J. A. Kim^{*}, “Numerical Analysis for Suppressing Unsteady Wake Flow on Wind Turbine Tower using Edison_CFD”, *Journal of Computational Fluids Engineering*, 18(1), 36-42.

Presentations

equal contribution

Conference presentations

- 2025 B. Koenig[#], **S. Kim**[#], S. Deng, “Combustion Chemistry Modeling with Kolmogorov-Arnold Network Ordinary Differential Equations” 14th U.S. National Combustion Meeting, Massachusetts, USA (USNCM 2025).
- 2024 G. Tsai[#], **S. Kim**[#], S. Deng, “Thermal Interaction of Inert Additives in Energetic Materials”, the Combustion Institute’s 40th International Symposium – Emphasizing Energy Transition, Milan, Italy (ISoC 2024).
- 2024 **S. Kim**, S. Deng, “Modeling Chemical Kinetics and Combustion Properties from Constant-Volume Combustion of Energetic Materials”, Spring Meeting of the Eastern States Section of the Combustion Institute, Georgia, USA (ESSCI 2024).

- 2024 G. Tsai[#], **S. Kim**[#], S. Deng, “Inert Additive Scaling Effects on Flame Propagation in Nanothermites,” Spring Meeting of the Eastern States Section of the Combustion Institute, Georgia, USA (ESSCI 2024).
- 2023 **S. Kim**, S. Deng, “Inferring Transport Properties and Chemical Kinetics of Reactive Materials from Flame Dynamics”, 50th Materials Research Society Fall Meeting, Massachusetts, USA (MRS 2023).
- 2023 **S. Kim**, A. Wang, J. Wen, S. Deng, “Effects of Reactivity and Thermal Transport on Burning Propagation of Nanothermites”, 13th U.S. National Combustion Meeting, Texas, USA (USNCM 2023).
- 2022 **S. Kim**, A. Johns, J. Wen, S. Deng, “Burning Structures and Propagation Mechanisms of Nanothermites”, 39th International Symposium on Combustion, Vancouver, Canada (ISoC 2022).
- 2022 **S. Kim**, A. Johns, J. Wen, S. Deng, “Non-Uniform Burning Propagation of Nanothermites”, Spring Meeting of the Eastern States Section of the Combustion Institute, Florida, USA (ESSCI 2022).
- 2022 **S. Kim**[#], J. Saadi[#], K. Pendowski, J. Chen, C. Ly, D. Sweeney, M. Yang, S. Deng, “Participatory & Computational Design of Improved Cookstoves”, ETHOS Conference, Virtual (ETHOS 2022).
- 2019 J. Song, **S. Kim**, T. C. Park, B-J. Cha, D. H. Lim, J. S. Hong, T. W. Lee, and S. J. Song, “Non-Axisymmetric Flows and Rotordynamic Forces in an Eccentric Shrouded Centrifugal Compressor – Part 1: Measurement”, Proceedings of ASME Turbo Expo, GT2019-90237, Arizona, USA (Turbo Expo 2019).
- 2019 **S. Kim**, J. Song, T. C. Park, K. Kim, and S. J. Song, “Measurement of Shrouded Radial Compressor Stability under Eccentric Conditions,” Global Power and Propulsion Society, GPPS-TC-2019-0068, Zurich, Switzerland (GPPS 2019).
- 2018 **S. Kim**, J. Song, B. Cha, T. C. Park, K. Kim, T. Lee, J. Hong, D. Lim, and S. J. Song, “Effects of Non-Axisymmetric Inflow on Vaneless Diffuser Rotating Stall”, Asian Congress on Gas Turbines, ACGT2018-TS50, Japan (ACGT 2018).
- 2012 **S. Kim**, D. H. Jin, and J. A. Kim, “Numerical Analysis for Suppressing Unsteady Wake Flow on Wind Turbine Tower”, The 1st EDISON Fluid-Thermo CFD Challenge, The Autumn Conference of Korean Society for Computational Fluids Engineering, 18(1), 33-36, Korea.

Workshop

- 2022 **S. Kim**[#], J. Saadi[#], K. Pendowski, J. Chen, C. Ly, D. Sweeney, M. Yang, S. Deng, “Participatory & Computational Design of Improved Cookstoves”, The Health of The Planet Showcase, MIT Mechanical Engineering, Massachusetts, USA.
- 2014 **S. Kim**, and S. J. Song, “Analytical Evaluation of Economic Feasibility of Cogeneration System in Building”, Seoul National University (SNU)—University of Tokyo (UT) Work Shop 2014, Japan.

Invited talk

- 2023 **S. Kim**, “Learning chemical kinetics and transport properties of energetic materials from combustion dynamics”, Seoul National University, Republic of Korea.

Teaching Experience

Teaching Assistantship

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| Fall 2023 | Thermal-Fluids Engineering 1 (2.005) | Massachusetts Institute of Technology |
| Spring 2015 | Applied Fluid Mechanics | Seoul National University |

Spring 2012	Basic Physics 1	<i>Seoul National University</i>
Spring 2011	Basic Physics 1	<i>Seoul National University</i>
Winter 2010	Pre-School College Mathematics	<i>Seoul National University</i>
Fall 2010	Basic College Mathematics 2	<i>Seoul National University</i>
Spring 2010	Basic Physics 1	<i>Seoul National University</i>

Advising and Mentoring Experience

Graduate Student Research

2024–Present	Hyein Choi (M.S. and Ph.D. Student, MIT) – Energetic materials combustion
2024–Present	Benjamin Koenig (Ph.D. Candidate, MIT) – Scientific machine learning
2023–Present	Nicolas Tricard (Ph.D. Candidate, MIT) – Inverse problem
2022–2024	Gwendolyn Tsai (M.S., MIT) – Energetic materials combustion

Undergraduate Research Opportunities Program (UROP)

2025	Wren Berlanga (B.S., MIT) – Hydrogen production (B.S. thesis)
2024–2025	Henry R. Smith (B.S., MIT) – Additive manufacturing (B.S. thesis)
2022	Evan Bell (B.S., MIT) – Additive manufacturing
2022	Pedro Alonso Hernandez (B.S., MIT) – Energetic materials combustion
2021–2023	Jason Chen (B.S., MIT) – Computational fluid dynamics
2020–2021	Meghana Vemulapalli (B.S., MIT) – Computational fluid dynamics
2020–2022	Averitt Johns (B.S., MIT) – Energetic materials combustion
2020	Sophie Longawa (B.S., MIT) – Energetic materials combustion

MIT Summer Research Program (MSRP)

2022	Ian Michael Rivera Tosado (B.S., UPenn) – Energetic materials combustion
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Senior Undergraduate Research Fellowship Program (SURF)

2024–2025	Yaojun Li (B.S., Tsinghua university) – Hydrogen production
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Selected Awards

2022–2023	Mathworks Mechanical Engineering Fellowship , <i>MathWorks</i>
2018–2024	KEF Scholarship , <i>Kwanjeong Educational Foundation</i>
2018–2019	MIT SMA2 Fellowship , <i>Massachusetts Institute of Technology</i>
2016–2017	BK 21 Plus Scholarship , <i>Ministry of Education, Korea</i>
2016–2017	Academic Excellence Scholarship , <i>Seoul National University</i>
2015–2016	Academic Excellence Scholarship , <i>Seoul National University</i>
2009–2015	National Scholarship for Science and Engineering , <i>Ministry of Education, Korea</i>

Services

Academic Services

Journal Reviewer

- *Proceedings of the Combustion Institute*
- *Applications in Energy and Combustion Science*
- *Computer Methods in Applied Mechanics and Engineering*
- *Knowledge-Based Systems*
- *Scientific Reports*

Conference Service

2025	Conference staff , USNCM 2025, MA, USA.
2019	Student assistant , MRS 2019 Fall Meeting, MA, USA.
2016	Student assistant , ASME Turbo Expo 2016, Seoul, Korea.
2014	Student assistant , ACGT 2014, Seoul, Korea.

Departmental and Laboratory Services

2019–2022	EHS representative , Deng Energy and Nanotechnology Group, MIT.
2019–2025	Proposal drafting , Deng Energy and Nanotechnology Group, MIT. Proposed main ideas, produced the first draft, and made joint revisions <ul style="list-style-type: none">• Developing Carbon-Neutral Aluminum/Cellulose Fuels for Clean Energy Conversion, MIT Skoltech Program Awards Pilot Grants 2020, PI: Professor Sili Deng (funded, award size: \$200,000)• Other proposals have been submitted to Army Research Office, Office of Naval Research, MIT Energy Initiative, and others (under review and in wait list).

Skills

Programming

Matlab, C, Java, Python, Julia, Mathematica, Labview

Computation

Ansys CFX, Fluent, ICEM, Cantera, Numerical Analysis, Optimization, Inverse Modeling, Machine Learning, Bayesian Statistics.

Laboratory

Optical System, High-Speed Imaging, Static/Dynamic Sensors, Data Acquisition System, Circuits, Machining (Mill, Lathe, and CNC), Additive Manufacturing, Material Characterization (SEM/EDS, XRD, Raman Spectroscopy, TGA/DSC).

Design

AutoCAD, Fusion360, SolidWorks, Catia.