

Sunjae Lee

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RESEARCH INTERESTS

My research focuses on contributing to the realization of a **magnetic-confinement fusion reactor**. Especially, I'm interested in these specific topics : 1) **kinetic MHD** in 2) **negative triangularity(NT)**, and 3) development of **AI-based high-performance simulations**.

EDUCATION

Seoul National University

College of Liberal Studies

Mar 2021 – Feb 2026 (Expected)

Seoul, Korea

- B.S. in **Computer Science & Engineering** and in **Physics**

- **Relevant Coursework:** Fusion Plasma Theory (Grad); Intro to Nuclear Fusion; E&M; Thermal & Stat. Physics; Mathematical Methods of Physics; Scalable HPC (Grad); Numerical Analysis; Intro to ML; Deep Learning

RESEARCH EXPERIENCES

Dept. of Nuclear Engineering, Seoul National University

Undergraduate Research Intern, 3DST Lab

Sep 2024 – Present

Seoul, Korea

3 Dimensional Stellarator & Tokamak Lab - Advisor: Prof. Jong-Kyu Park

- Conducted stability analysis of NT using ideal, drift-kinetic, and kinetic MHD models with DCON and GPEC suite
- Found NT has stronger kinetic stabilization effect due to closed-orbit trapped particle's resonance
- Identified a second-stability region of the $n = 1$ in DIII-D NT and analyzed the effect of magnetic shear

Princeton Plasma Physics Laboratory (PPPL)

Research Student, SNU–PPPL Summer Collaboration

Jul 2025 – Aug 2025

Princeton, NJ, USA

- Participated in the PPPL–SNU Summer Research Collaboration, focusing on nonlinear 3D MHD modeling, transport analysis, and pilot-plant design for NSTX-U and KSTAR plasmas
- Learned and applied the BALOO code for edge-stability analysis in the K-DEMO project and NT

Dept. of Nuclear Engineering, Seoul National University

Undergraduate Research Intern, NUPLEX Lab

Sep 2023 – Aug 2024

Seoul, Korea

Seoul National University Plasma & Ion Beam Laboratory - Advisor: Prof. Y. S. Hwang

- Designed and implemented a database for the Versatile Experiment Spherical Torus(VEST) using the IMAS–HSDS data architecture
- Developed a post-processing tool (VAFT) for automated analysis of experimental diagnostic shot data
- Explored operational space for the first time, identifying performance limits from current-driven instabilities

PUBLICATIONS

J: Journal, C: Conference

- [J.1] Hong-Sik Yun[†], Sunjae Lee[†], Laurent Jung, et al. (2025). **Developing an IMAS-Compatible Platform for the University-Level Tokamak VEST and Its Application in Operating Characteristics Analysis.** *Plasma Physics and Controlled Fusion*, DOI:10.1088/1361-6587/ae1b6a

[†] These authors contributed equally to this work.

ORALS & POSTERS

P: Poster presentations, O: Oral presentations

- [P.1] S. J. Lee, J. B. Cho, O. Nelson, C. Paz-Soldan, J.-K. Park. (2025). **Kinetic MHD Stability of Low-n Modes in Negative Triangularity Plasmas**. *67th Annual Meeting of the APS Division of Plasma Physics*, Long Beach, CA, USA (Nov 2025)
- [P.2] S. J. Lee, J. B. Cho, O. Nelson, C. Paz-Soldan, J.-K. Park. (2025). **Kinetic stability of negative-triangularity plasmas**. *29th Workshop on MHD Stability Control*, Princeton, New Jersey, USA (Jul 2025)
- [P.3] S. J. Lee, J.-K. Park, H.S. Yun, L. Jung, G. W. Nam, G. G. Seo, J. M. Lee (2025). **Standardized Data Infrastructure for Tokamak: Implementation in VEST (Versatile Experiment spherical tokamak)**. *2025 Spring meeting of the Korean Physics Society*, Seoul, Korea (Apr 2025)
- [P.4] S. J. Lee, H.S. Yun, Laurent Jung, Jung-Hwa Kim, Y.S. Hwang (2024). **Improvements of database system and analysis suite in VEST**. *3rd International Fusion and Plasma conference (IFPC)*, Seoul, Korea (Jun 2024)

PROJECTS

Perturbed Equilibrium Code Hackathon – Columbia Fusion Research Center

Tools: Julia, Fortran, GPEC (reference), Plasma Physics Modeling

Jul 2025

Columbia, NY, USA 

- Participated in a hackathon to reproduce fortran DCON and GPEC's energy-principle-based ideal MHD stability solver in Julia version GPEC(MPEC)
- Developed coordinate transformation and numerical routines to compute stability analysis from equilibrium

High-Performance CUDA Programming Project – Accelerator Programming Summer School

Tools: CUDA, NVIDIA GPU, Nsight, C++

Jun 2024

Seoul, Korea

- Implemented parallel programs in CUDA/C++ for high-throughput computation in GPU
- Analyzed performance using Nsight Systems, identifying bottlenecks in memory access and execution flow

Text-to-Image Generation with Conditional GAN - 2023 OUTTA Deep Learning Bootcamp

Tools: PyTorch, Conditional GAN

Jun 2023 – Aug 2023

Seoul, Korea

- Built a text-to-image generation model using conditional GAN architecture and Ranked 2 out of 60 teams

TEACHING EXPERIENCE

Teaching Assistant, Computer Architecture — SNU

Fall 2025

LEADERSHIP & VOLUNTEER EXPERIENCES

Vice President, Sorijigi (Classical Music Listening Club) – SNU

Sep 2021 – Feb 2023

Volunteer, Habitat for Humanity Korea (Snuhabitat) – SNU

Sep 2021 – Feb 2022

Volunteer, Tail – SNU

Aug 2022 – Dec 2023

SKILLS & ADDITIONAL INFORMATIONS

- Programming Languages:** Python, C/C++, Fortran, Julia, Linux, CUDA, MATLAB, OpenCL, MPI, OpenMP
- Simulation Tools:** DCON, GPEC, BALOO, KineticEFITtime
- TOEFL:** 100/120 (Reading 27, Listening 28, Speaking 24, Writing 21)