

# JIAYI ZHOU

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## EDUCATION

### School of Mathematical Sciences, Peking University

B.S. in Computational Mathematics

Beijing, China

2022 - 2026 (*expected*)

GPA: 3.624 / 4.00

**Selected Courses:** Ordinary Differential Equations (90.5), Partial Differential Equations (91), Mathematical Statistics (100), Inverse Problems and Data Assimilation (95).

**Research Interests:** Scientific Machine Learning, Neural Operators, Out-of-distribution Generalization.

## PUBLICATIONS

Jiayi Zhou, Atharva Aalok, Valentin Duruisseaux, Xinyi Li, Juan Alonso, Anima Anandkumar. Robust Shape Optimization with Neural Shape Representations and Neural Operators. *In preparation*.

Jiayi Zhou, Valentin Duruisseaux, Daniel Zhengyu Huang, Anima Anandkumar. Boundary-Augmented Neural Operators for Better Generalization to Unseen Geometries. *NeurIPS AI4Science Workshop*, 2025.

Chenyu Zeng\*, Yanshu Zhang\*, Jiayi Zhou\*, Yuhan Wang, Zilin Wang, Yuhao Liu, Lei Wu, Daniel Zhengyu Huang. Point Cloud Neural Operator for Parametric PDEs on Complex and Variable Geometries. *Computer Methods in Applied Mechanics and Engineering*, 2025. \* denotes equal contribution

## RESEARCH EXPERIENCES

### Shape Optimization with Neural Representations and Neural Operators | Caltech

Advisor: Prof. Anima Anandkumar

Jun 2025 - Present

- Leader of the project, fully founded by Caltech.
- Developed a neural shape representation that guarantees non-self-intersection and enables stable optimization.
- Constructed high-fidelity Euler and RANS airfoil datasets.
- Achieved a 16% improvement in lift on the subsonic Euler dataset.
- Exploring 3D surface representations with encoder-decoder architectures for robustness against out-of-distribution geometries.

### Operator Learning for Geometric Out-of-distribution Generalization | Peking University & Caltech

Advisors: Prof. Daniel Zhengyu Huang, Prof. Anima Anandkumar

Sep 2024 - Present

- Leader of the project.
- Developed a neural operator architecture that explicitly encodes boundary geometry and conditions and enables full-field prediction from boundary inputs.
- Generated a high-quality dataset of Poisson problems using the boundary element method (BEM).
- Investigated the geometric generalization behavior — model trained on single airfoils successfully predicts flow over airfoils with flap with about 10% relative  $L_2$  error
- Exploring analytical formulations of the solution operator for different equations on variable geometries and methods to incorporate normal information.

### Operator Learning for Singularity and Scale-Invariance | BIMSA

Advisor: Prof. Mahdi Hormozi

Apr 2025 - Jun 2025

- Developed a Mellin transform based operator learning framework to strictly enforce scale-invariance.

- Analyzed scale-invariant behaviors in classical equations such as the Lévy and Smoluchowski equations.

## Operator Learning for Complex and Variable Geometries | Peking University

Advisor: Prof. Daniel Zhengyu Huang

*Feb 2024 - Apr 2025*

- Extended the Fourier Neural Operator using Riemann-sum numerical integration and accounting for point density functions to support complex point-cloud geometries.
- Compared basis functions among Gaussian kernels, PCA bases, and Fourier bases, concluding that the Fourier basis provides greater stability and general applicability
- Explored low-rank approximations of convolution kernels, including Tucker decomposition and  $\mathcal{H}$ -matrix structures, to reduce parameter counts.
- Incorporated derivative information as local features, yielding around 10% performance improvement across multiple datasets.
- Validated the model on diverse datasets, including Darcy, Airfoils with flap, Shape-Net Cars, and the Ahmed Bodies, etc.

## AWARDS & HONORS

SURF Award   Caltech	2025
The First Prize   China Undergraduate Mathematical Contest in Modelling	2024
The Third Prize Scholarship   Peking University	2024
The Third Prize Scholarship   Peking University	2023

## SKILLS

**Languages:** Chinese, English (TOEFL 107, GRE 325+3)

**Programming:** Python, C/C++, MATLAB, L<sup>A</sup>T<sub>E</sub>X.

**Hobbies:** Badminton, Piano, Saxophone.