Yu Jun Loo

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Research Summary

I develop fast, stable, and accurate numerical methods for fluid structure interaction such as falling plates and thin membranes. I combine rigorous mathematics with high-performance computing to make accurate inviscid simulations that well approximate full Navier–Stokes solvers at a fraction of the cost. Parallel to this, my research addresses tensor decomposition and complex analytic methods in singular integral theory that make such methods possible.

Publications

2025 **Falling plates with leading edge separation**,
Physical Review Fluids (10), "Editor's Suggestion",

- Developed a numerical framework using specialized quadrature and regularization that enables stable, continuous leading-edge vortex shedding in inviscid simulations.
- Simulated fluttering and tumbling dynamics previously inaccessible to such models and predicted a flutter–tumble transition consistent with experiments and viscous simulations.

With Silas Alben

2025 **Hölder regularity of the $\bar{\partial}$-equation on the polydisc**,
Complex Variables and Elliptic Equations,

- Solved a classical open problem on Hölder-regular solution operators for $\bar{\partial}$ in product domains and obtained optimal estimates for the singular integral solution operator.

With Alexander Tumanov

Preprints and ongoing work

2026 **Comparison of inviscid and viscous vortex shedding for translating and rotating plates**, *Preprint*, (Submitted),

- We perform a systematic comparison of an improved inviscid vortex-sheet model with direct Navier–Stokes simulations across ≈ 70 distinct prescribed motions.
- We demonstrate good accuracy (10–20% on average) in computed forces over a broad class of motions, and clarify the regimes in which much faster inviscid models provide reliable force prediction and explanation.

With Silas Alben

2026 **Quantics-tensor-train accelerated $\mathcal{O}(N)$ vortex summation**, *Manuscript in preparation*, (Submission planned Spring 2026),

- Developed a quantum inspired tensor-train–accelerated $\mathcal{O}(N)$ vortex summation method independent of particle positions.

With Shravan Veerapaneni

2026 **Optimal membranes for hover**, *Manuscript in preparation*, (Submission planned Summer 2026),

- Extended our inviscid model to elastic membranes to obtain elastic parameters that maximize lift efficiency in hovering motions.

With Silas Alben

Computational projects

2024 **GPU accelerated entropic lattice Boltzmann solver with mixed precision (C++/CUDA)**, *Link to code*,

- Implemented a 2D entropic LBM solver in CUDA/C++, with mixed-precision (FP16/FP64) arithmetic to balance stability and GPU throughput.
- $\approx 500\times$ speed up from serial for moderate problem sizes.

Computational skills

Languages and frameworks : C++, Python, Julia, Matlab, JAX, Git, Slurm.

Parallel computing : CUDA, MPI, OpenMP.

Education

2022– **Ph.D. in Mathematics and scientific computing**,
University of Michigan, Ann Arbor, GPA: 4.00.
Advisor: Silas Alben
Expected graduation: May 2027

2019–2022 **BSc. Mathematics**, *Summa cum laude with highest distinction in mathematics*
University of Illinois, Urbana-Champaign, GPA: 4.00, Bronze Tablet (top 3%).
Advisor: Alexander Tumanov

Awards and Fellowships

2025 **Rackham dissertation fellowship**, *University of Michigan*,
Competitive fellowship supporting full-time research for a semester during the final years of the Ph.D..

2022 **Roy H. Brahana prize**, *University of Illinois at Urbana-Champaign*,
Awarded to the student with the most exceptional undergraduate mathematics career.

2021 **Elizabeth R. Bennet scholarship**, *University of Illinois at Urbana-Champaign*,
Awarded for academic excellence in mathematics.

Talks and conferences

2026 **USNC-TAM**, *(Accepted Talk)*, "Inviscid and viscous vortex shedding from a zero-thickness plate".

2025 **DisCoVor 2025**, *(Accepted Talk)*, "Leading edge vortex shedding induces fluttering and tumbling in falling plates".

2025 **G2S3 2025**, *(Summer school)*, Gene Golub SIAM summer school in pattern formation.

Professional service

2024– **Reviewer**, *Journal of Fluid Mechanics*, 4 manuscripts.

Teaching experience

2022– **Graduate student instructor**, *University of Michigan, Ann Arbor*,
Calculus I-II; Differential equations.

2021–2022 **Advanced course grader**, *University of Illinois at Urbana-Champaign*,
Honors category theory.