

JINGYI (JENNY) LIU

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EDUCATION

University of Southern California Los Angeles, CA, U.S.
Ph.D., Mechanical Engineering - fluid dynamics (Excellence in Teaching Award, Viterbi School of Engineering) 05.2025
M.S., Applied Physics (Electrical Engineering), and M.S., Mechanical Engineering 2023, 2019
Xi'an University of Technology Xi'an, China
B.S., Mechanical Design and Manufacturing Automation (1st price in Mathematical Contest in Modeling, 3rd prize in China University Robot Contest) 2017

RESEARCH PROJECTS

Flow Physics and Nutrient Transport for Ciliated microorganisms, Optimization 2019-2023

- Derived a mathematical model for fluid induced by ciliated microorganism, simulated nutrient transport by considering advective-diffusive transport and estimated organisms' feeding rate.
- Implemented numerical schemes for solving the governing partial differential equation using Legendre-spectral method and finite difference method, with reduced spatial computational complexity; performed **error analysis** for numerical methods validation, and **asymptotic analysis** for extreme parameters.
- Identified the optimal cilia beating motion by formulating a **PDE-constraint optimization** problem; **adjoint-based** method, functional analysis, **gradient-based** search.
- Identified the optimal cell design for extra-cellular transport: find the optimal cilia and 'mouth' arrangements that maximize nutrient absorption rate; **inverse design**.
- Collected and analyzed biological data of organisms and identified correlation of size and fluid data with model predictions.

Feeding of ciliates in concentration gradient 2021-2024

- Built mathematical model and derived an analytical solution to diffusion in a concentration gradient.
- Implemented numerical schemes to solve unsteady advection-diffusion equation with prescribed cilia induced flow; identified that enhanced feeding requires adaptive alignment of cilia motion with concentration gradient.

Flow formation in a spherical confinement 2022-present

- Formulated a mathematical model for collective oscillators on a spherical surface, simulated dynamics and analyzed the **emergent phase synchronization** phenomenon, aiming to understand the flow formation symmetry-breaking phenomenon in biological system. **Monte Carlo** simulations.

PUBLICATIONS

- **J.Liu**, Y. Man, J. Costello and E. Kano. (accepted) Optimal Feeding of Swimming and Attached Ciliates. [archive](#)
- **J.Liu**, Y. Man, J. Costello and E. Kano. [Feeding Rates of Sessile and Motile Ciliates are Hydrodynamically Equivalent](#). *eLife*, 13.
- **J.Liu**, J. Costello and E. Kano. (under review) Flow Physics of Nutrient Transport Drives Functional Design of Ciliates.
- **J.Liu**, Y. Man and E. Kano. (submitted) Nutrient Transport in Concentration Gradients. [archive](#)
- **J.Liu** and E. Kano. (in preparation) Symmetry-Breaking by Feedback Flow Control in Stochastic Systems.

TECHNICAL SKILLS

- **Technical skills:** CFD, optimization, PDE analysis, Monte Carlo simulation, deep learning, physics-informed neural network, CNN, RNN, LSTM, Reinforcement Learning.
- **Tools:** Matlab, Python (Pandas, Numpy, Tensorflow, Keras, Sklearn), C++, GitHub

WORK EXPERIENCE

Research assistant Los Angeles, CA, USC, 2022-present

- Constructed and planned summer lab projects for master students, including PIV analysis on image sequence and videos.
- Performed presentations and held posters sessions on professional conferences and workshops.
- Gave two guest lectures to class with 300 students on topic: *Swimming in low Re numbers*.

Teaching assistant (AME 341 a,b Mechoptronics Laboratory) Los Angeles, CA, USC, 2019-2022

- Led labs for junior undergraduate experimental courses, taught and facilitated hands-on experiments, including digital image correlation, signal processing and acoustic wave testing, taught quantitative analysis skills, like FFT, spectral analysis.
- Served on junior project review committees, provided guidance and evaluation on final reports and presentations.

Student research team leader (under water vehicle research group) Xi'an, China, XUT, 2016-2017

- Directed a project through full timeline, guided a multidisciplinary team through every stage from concept to completion, allocated tasks among team members.

CONFERENCES/WORKSHOPS

- **J.Liu**, J. Costello and E. Kano. (2024) Enhanced feeding with structural coordination of ciliary band and oral apparatus, *American Physical Society (Division of Fluid Dynamics), 77th Annual meeting, Salt Lake City, Utah*.

- KN Banoth, **J.Liu** and E. Kanso. (2024) Synchronization and Fluid Transport in Heterogeneous Ciliary Carpets, *American Physical Society (Division of Fluid Dynamics), 77th Annual meeting, Salt Lake City, Utah.*
- **J.Liu** (2024) Evaluating Feeding Strategies in Marine Ciliates. *Computational Tools for PDEs with Complicated Geometries and Interfaces. Flatiron Institute, Simons Foundation, New York.*
- **J.Liu**, Y. Man, J. Costello and E. Kanso. (2023) Feeding Rate of motile and sessile ciliates are asymptotically equivalent, *American Physical Society (Division of Fluid Dynamics), 76th Annual meeting, Washington, DC.*
- **J.Liu** (2023) Modeling flow physics and nutrient acquisition in microorganisms. *Janelia Theoretical Biophysics Workshop, Virginia.*
- **J.Liu**, Y. Man, J. Costello and E. Kanso. (2023) Optimal feeding of motile and sessile ciliates are asymptotically equivalent, *SoCal Fluids XVI conference, SDSU, CA.*
- **J.Liu**, Y. Man, J. Costello and E. Kanso. (2022) Feeding of sessile ciliates in uniform and nonuniform nutrient concentrations. *American Physical Society (Division of Fluid Dynamics), 75th Annual meeting, Indianapolis, IN.*
- **J.Liu**, Y. Man, J. Costello and E. Kanso. (2022) Nutrient uptake enhancement of sessile in concentration gradients, *SoCal Fluids XV conference, UCLA, CA.*
- **J.Liu**, Y. Man, and E. Kanso. (2021) Nutrients uptake enhancement of fixed ciliated microorganisms in concentration gradients. *American Physical Society (Division of Fluid Dynamics), 74th Annual meeting, Phoenix, AZ.*
- **J.Liu** and E. Kanso. (2020) Optimal feeding of ciliated microorganisms in concentration gradients. *American Physical Society (Division of Fluid Dynamics), 73rd Annual meeting, Virtual.*
- **J.Liu** and E. Kanso. (2019) Nutrients uptake and locomotion of ciliated microorganisms, *SoCal Fluids XIII conference, USCB, CA.*

HONORS/AWARDS

- Jenny Wang Excellence in Teaching Award, Viterbi School of Engineering, USC.
- 3rd prize, China University Robot Contest (National).
- 1st prize, Contemporary Undergraduate Mathematical Contest in Modeling (Province).
- Pacemaker to Merit Student in academic, XUT.
- 1st price in Extracurricular and Academic Contest, XUT.
- Excellence Award, Xi'an Conservatory of Music Piano Competition.

ACDEMIC PROJECTS

Machine learning: Partial differential equation solver by PINN 2023

- Built physics-informed neural networks(PINN) and Generative adversarial networks(GAN) for solving Allen-Cahn equation with 0.5% observations with unknown parameters.

Machine learning: Images recognition/classification 2023

- Constructed and trained deep convolutional neural networks for recognizing images, Tensorflow.

EARLIER COURSE/RESEARCH PROJECTS

Optical wave propagation simulations 2022, USC

- Simulated wave scattering and propagation, applying in 2D metasurface and communication fibers design.
- Numerically solving Nonlinear Schrödinger equation by finite difference and Split-step Fourier method.

Remotely Operated Vehicle design (Prof. Xiaohui Zhang) 2016-2017, XUT

- Designed the ROV framework and analyzed its working deformation under the water. Ansys (Workbench), Solidworks.
- Designed the propulsion system; designed the seal structure by applying the spring-piston pressure auto-balancing structure.
- Designed the propeller by using HydroComp ProExpert; made prototypes and adjusted the design parameter by testing the working performance of prototypes.

Self-balance two-wheel Bicycle design (Prof. Xiaohui Zhang) 2015-2016, XUT

- Designed a self-balanced system by conservation of angular momentum theory.
- Design the structure of a bicycle with applying a fly wheel for self-balance system; simulated working performance in ADAMS.

Application of Sunlight-LED three-dimensional intelligent lighting to greenhouse plant (Prof. Yuanhe Tang) 2014, XUT

- Collected and organized the data of different light wave band for different plants.
- Report the results and analysis.