Changhao Li

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Research Interests

- Soft matter physics, solid mechanics, non-equilibrium thermodynamics and statistical mechanics
- Morphogenesis, self-patterning, phase separation and chaos in active matter
- Nonlinear, history-dependent mechanics and rheology of tissues and biological materials
- Physics-informed machine learning, multiscale modeling methods, parallel and high-performance computing

Education

The Pennsylvania State University — State College, PA, USA
- *Ph.D. in Engineering Mechanics* — *Aug 2018 - Aug 2024*
  Dissertation: Multiscale modeling of biological active matter — *Advisor: Dr. Sulin Zhang*

Beihang University — Beijing, China
- *Bachelor of Engineering in Engineering Mechanics* — *Aug 2014 - Jul 2018*
  Thesis: Elasticity of fibrous composites with different microstructures — *Advisor: Dr. Yuli Chen*

The University of Tokyo — Tokyo, Japan
- *Exchange undergraduate student* — *Sep 2017 - May 2018*
  Project: Thermoelectric transport modeling of carbon nanotube junctions — *Advisor: Dr. Junichiro Shiomi*

Honors and Awards

- Dale and Jeanne Mosier Fund for Excellence *2023*
- C. Norwood Wherry Memorial Graduate Fellowship in Engineering *2021*
- Professor and Mrs. Ralph U. Blasingame Memorial Graduate Fellowship in Engineering *2021*
- Harry G. Miller Fellowship in Engineering *2020*
- H. Marcus Dean's Chair in Engineering Scholarship *2019*
- Penn State University Graduate Fellowship *2018*
- Outstanding Graduates of Beihang University *2018*

Publications

- Li, C., Feng, L., Park, Y.J., Yang, J., Li, J., & Zhang, S. (2024). Machine learning traction force maps for contractile cell monolayers. ***Extreme Mechanics Letters***, p.102150.
  DOI: https://doi.org/10.1016/j.eml.2024.102150

- Li, C., Nijjer, J., Feng, L., Zhang, Q., Yan, J., & Zhang, S. (2024). Agent-based modeling of stress anisotropy driven nematic ordering in growing biofilms. ***Soft Matter*, accepted**.
  Highlighted by Soft Matter Editor as the front cover article.
  DOI: https://doi.org/10.1039/D3SM01535A

- Nijjer, J., Li, C. (co-first author), Kothari, M., ..., Cohen, T., Zhang, S., & Yan, J. (2023). Biofilms as self-shaping growing nematics. ***Nature Physics***, 19(12), pp.1936-1944.
  Hightlighted by Penn State News, Yale News and *Nature Physics* at the same issue.
  DOI: https://doi.org/10.1038/s41567-023-02221-1

- Li, W., Li, C. (co-first author), Zhang, G., ..., & Wang, Q. (2021). Molecular ferroelectric-based flexible sensors exhibiting supersensitivity and multimodal capability for detection. ***Advanced Materials***, 33(44), p.2104107.
  DOI: https://doi.org/10.1002/adma.202104107

- Nijjer, J., Li, C., Zhang, Q., Lu, H., Zhang, S., & Yan, J. (2021). Mechanical forces drive a reorientation cascade leading to biofilm self-patterning. ***Nature communications***, 12(1), p.6632.
  Highlighted by Nature Communications Editor.
  DOI: https://doi.org/10.1038/s41467-021-26869-6

- Feng, L., Zhao, T., Xu, H., Shi, X., Li, C., Hsia, K.J., & Zhang, S. (2023). Physical forces guide curvature sensing and cell migration mode bifurcating. ***PNAS nexus***, 2(8), p.pgad237.
  DOI: https://doi.org/10.1093/pnasnexus/pgad237

- Yao, B., Hong, W., Chen, T., Han, Z., Xu, X., Hu, R., Hao, J., Li, C., ..., & Wang, Q. (2020). Highly stretchable polymer composite with strain-enhanced electromagnetic interference shielding effectiveness. ***Advanced Materials***, 32(14), p.1907499.
  DOI: https://doi.org/10.1002/adma.201907499

In Preparation/Under Review:

- Ataie, Z. Li, C. (co-first author), Risbud, A., Kheirabadi, S., Zhang, S., & Sheikhi. A. (2024), Cellular snowballing: cell migration drives self-assembly of cell-hydrogel biohybrid spheroids. **submitted to *PNAS***.
- Li, C., Ataie, Z., Sheikhi. A., & Zhang, S. (2024), Agent-based modeling for assembling dynamics of cellular organoids. **In Preparation**.

Presentations

- Li, C., Zhang, S., (2024). Mechanically guided self-patterning of growing biofilms. ***ESM Today Workshop 2024***. **Oral presentation**.
- Li, C., Zhang, S., Yan, J., & Nijjer, J. (2023). Mechanically guided self-patterning of growing biofilms. ***SES 2023 Annual Meeting***. **Oral presentation**.
- Zhang, S., Li, C., Feng, L., Park, Y., Yang, J., Li, J. (2023). Keynote: Machine learning traction force maps of cell monolayers: toward a digital traction force microcopy. ***SES 2023 Annual Meeting***. **Keynote presentation**.
- Li, C., Zhang, S., (2023). Machine learning traction force maps of cell monolayer. ***ESM Today Workshop 2023***. **Poster**.
- Nijjer, J., Henzel, T., Li, C., Zhang, S., Cohen, T. and Yan, J., (2022). Growth of bacterial biofilms at interfaces. ***2022 APS March Meeting***. **Oral presentation**.
- Li, C., Zhang, S., (2022). Mechanical stresses pattern cell ordering in bacterial biofilms. ***2022 LiMC2 Workshop***. **Poster**.
- Zhang, S., Li, C., (2022). A deep-learning based painter to predict cell traction force maps. ***USNC/TAM 2022***. **Oral presentation**.
- Li, C., Nijjer, J., Yan, J. and Zhang, S. (2021). Agent-based modeling for biofilm growth under mechanical confinement. ***2021 APS March Meeting***. **Poster**.
- Nijjer, J., Li, C., Zhang, S. and Yan, J., (2021). Self-organization of bacteria in confined interstitial biofilms. ***2021 APS March Meeting***. **Oral presentation**.
- Li, C., Zhang, S., (2021). Agent-based modeling of *V.cholerae* bacteria biofilms. ***ESM Today Workshop 2021***. **Poster**.

Skill Highlights

- Agent-based modeling and discrete element modeling for active biological matter
- Nonlinear, time-dependent, multi-physics mean-field modeling for active matter and electrochemical systems
- Machine learning and deep learning for biomedical image data and time series
- Rich experience on interdisciplinary collaboration and solid training on scientific writing/visualization

Tools: Finite Element Analysis (ABAQUS, COMSOL, FEniCSx), Programming (C++, Python, Matlab), Machine Learning (PyTorch, Keras), Molecular Dynamics (LAMMPS, Material Studio), High-performance Computing (CUDA, Eigen), Phase-field Modeling.

Industry Experience

- **Dassault Systèmes - SIMULIA** — Pleasonton, CA
  Industry process expert intern — *May 2023 - Sep 2023*
  - **C++ Multiphysics Solver**: Using finite difference method to solve Darcy-Nernst-Planck-Poisson system. Testing numerical efficiency and stability of various iterative methods.
  - **Deep-Learning-Based Microstructure Generator**: Using a generative adversarial networks to transform 2D experimental images of battery electrode into 3D digital microstructures.
  - **High-fedelity Fuel Cell Simulations**: Using FEniCSx to build a FEM-based application for simulating multiphysics processes in fuel cells, including mass/charge transfer and nonlinear electrochemical kinetics.

Other Experience

Journal Reviewer (Extreme Mechanics Letters (13), International Journal of Solids and Structures (2), STAR Protocols (2), ASME Open Journal of Engineering (1)); **Teaching Assistant** (5 semesters for Statics and Dynamics); **Student Judge** (ESM Today Workshop 2019, 2022, 2023), **Membership** (American Physical Society, Center for Lignocelluose Structure and Formation)