清华大学 清华学堂钱学森班 Tsien Excellence in Engineering Program

Yunfan Huang 黄云帆, PhD Candidate

Department of Engineering Mechanics, Tsinghua University

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Education Background

- **2019/08-2025/07** ***Doctor of Philosophy*** Tsinghua University Department of Engineering Mechanics
  - **Major**: Power Engineering and Engineering Thermal Physics (Admission by Recommendation)
  - **Dissertation**: Mechanism of electrokinetic transport of immiscible liquid-liquid interface (**Supervisor**: Prof. Moran Wang)
  - **Applications**: Enhanced oil recovery with low-salinity waterflooding, Electrolyte filling in rechargeable batteries
- **2018/10-2019/01** ***Visiting Student*** Purdue University School of Mechanical Engineering
  - **Project:** Optimization of the pillar array distribution for rare cell analysis (**Supervisor:** Prof. Steven T. Wereley)
  - **Applications**: Reaction efficiency enhancement in point-of-care fluidics for rare cell analysis
- **2015/08-2019/07** ***Bachelor of Engineering*** Tsinghua University Department of Engineering Mechanics
  - **Major**: Theoretical and Applied Mechanics (Tsien Excellence in Engineering Program, TEEP) (Ranked 6/29, GPA 3.78/4.00)
  - **Thesis:** Electron hydrodynamics in micro/nanoscale low-dimensional materials (**Supervisor**: Prof. Moran Wang)
  - **Applications**: Super-ballistic electron transport in 2D materials, Thermal management of electronic devices

Research Experiences

Research Interests

- Electrokinetic flows, micro-/nano-fluidics, complex flows
- Hydrodynamic effect in electron and phonon transport
- Kinetic modeling and multiscale simulation of multiphysical transport

Research Projects

Main: electrokinetics at liquid-liquid interface, electron hydrodynamics

- **2019-2025** ***Doctoral dissertation***, also supported by NSFC & NKRD Tsinghua University
  - Project: Electrokinetic multiphase flow in porous media & Multiphysical microflow simulation software development
- **2017-2019** ***Bachelor's thesis*** & Open Research for Innovative Challenges TEEP
  - Project: Mechanism of electron transport in two-dimensional materials based on electron hydrodynamics

Supplement

- **2021/07-08** Internship (in Company) DORIGHT
  - Project: Review and simulation of flow and heat transfer in a high-temperature air preheater with helical baffles
- **2018-2019** Senior Undergraduate Research Fellowship Purdue University - TEEP
  - Project: Optimization of the pillar array distribution for rare cell analysis in point-of-care diagnostics
- **2018/07-08** Internship (in Institute) Beijing CSRC
  - Project: Implementation of Zoltan interface for mesh partitioning in high-precision CFD software
- **2017-2018** Advanced Placement Course (Finite element method) TEEP
  - Project: Development of complex elements and multifunctional finite element programs for cable-stayed bridges

Possible Engagement

- **Physico-chemical hydrodynamics**: electrochemical energy conversion, soft matter, collective behavior of living matter
- **Quantum hydrodynamics in solids**: vortex hydrodynamics in electron transport, odd viscosity of electron fluid

Other Experiences

Academic Skills

- **Theoretical kinetic modeling**: electron-phonon transport in solids, ion-fluid coupling transport in electrolyte solutions
- **Algorithm development**: particle mesoscopic methods (LBM), PDE solvers (DOM, FVM/FEM); in Matlab/Fortran/C
- **Numerical simulation**: COMSOL, ANSYS Fluent, ABAQUS, OpenFOAM; AutoCAD, SolidWorks, Origin, ParaView
- **Experiment platform setup**: microfluidic measurement system, including design, fabrication, test and data processing
- **Engineering system design**: optimization of complex bridge / heat exchangers, electrical and control system in CMG

Academic Experiences

- 2021-2023/Fall, Teaching Assistant of *Heat and Mass Transfer* (Prof. Moran Wang), Tsinghua University
- 2018/07, Participant (1/40) in Airbus Airnovation Summer Academy, Cranfield University (UK)

Social Practices and Hobbies

- 2020/11, Technology Industry Survey of Hangzhou, TEEP, Tsinghua University
- 2017-2018/Winter, Industrial Survey of Hong Kong/Singapore, Student Association for Sci & Tech, Tsinghua University
- **Hobbies**: Music (Violin, Piano, Chorus), Sports (Badminton, Table tennis), Reading (Sci-Fi, Sci-Tech history)

Honors & Awards

In Research+

- 2024.08 Tsinghua Doctoral Travel Grant for International Conferences (Top-Tier)
- 2021.12 Tsinghua Comprehensive Excellence Scholarship (1st Prize)
- 2019.07 Tsinghua "Future Scholar" Scholarship
- 2019.07 Bachelor's Thesis with Honor (both in Tsinghua, and in Beijing)
- 2018.02 Honorable Mention in the Mathematical Contest in Modeling (MCM, held by SIAM)

In Education+

- 2023.12 Excellent Teaching Assistant (Eng. Mech. Dept.)
- 2021.12 Tsinghua Excellent Mentor for Undergraduate
- 2019.07 Tsinghua Outstanding Graduate (Bachelor)
- 2016.10 National Scholarship
- 2015.10 Tsinghua Xuetang Scholarship (Outstanding Innovative Talent Cultivation Program)

Supplemental materials

A. Publication Lists

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Journal papers (topical review)

1. **Y.F. Huang** and M. Wang*. Electrokinetics at liquid-liquid interfaces: Physical models and transport mechanisms. ***Advances in Colloid and Interface Science***, **342**: 103518, 2025.

✧ **Y.F. Huang** and M. Wang*. Electrokinetic multiphase hydrodynamics: From fundamental physics to advanced methods. ***Applied Physics Reviews***, 2025. *Under review* (*Major revision*)

✧ **Y.F. Huang**, H.Y. Chen, W. Liu, M. Wang*. Electrokinetic transport in porous media: A pore-scale perspective. ***Advances in Colloid and Interface Science***, 2025. *In preparation*

Journal papers (research - first (co-)author)

2. **Y.F. Huang** and M. Wang*. Solvent mixing and ion partitioning effects in spontaneous charging and electrokinetic flow of immiscible liquid-liquid interface. ***Physical Review Fluids***, **9**: 103701, 2024 (Highlighted as **Editors' Suggestion**)
3. A. Alizadeh[#], **Y.F. Huang**[#], F.L. Liu, H. Daiguji, M. Wang*. A streaming-potential-based microfluidic measurement of surface charge at immiscible liquid-liquid interface. ***International Journal of Mechanical Sciences***, **247**: 108200, 2023
4. X. Ran[#], **Y.F. Huang**[#], M. Wang*. A hybrid Monte Carlo-discrete ordinates method for phonon transport in micro/nanosystems with rough interfaces. ***International Journal of Heat and Mass Transfer***, **201**: 123634, 2023
5. **Y.F. Huang** and M. Wang*. Nonnegative magnetoresistance in hydrodynamic regime of electron fluid transport in two-dimensional materials. ***Physical Review B***, **104**: 155408, 2021

✧ **Y.F. Huang** and M. Wang*. Electrokinetic transport regulation at liquid-infused surface by liquid depletion and ion partition. ***Physical Review Fluids***, 2025. *In revision (Minor revision)*

✧ **Y.F. Huang** and M. Wang*. Electrophoresis of charged dielectric droplet with ion concentration polarization effect. ***Physical Review Fluids***, 2025. *Under review*

Journal papers (research - others)

6. M.B. Zhang, Z.G. Tian, **Y.F. Huang**, M. Wang*. Gas flow regimes and transition criteria in porous media. *Physical Review Fluids*, **10**: 024303, 2025
7. W. Liu, **Y.F. Huang**, M. Wang*. Extended space charge and transport near ion-selective surfaces. *International Journal of Mechanical Science*, **287**: 109933, 2025
8. Z.G. Tian, **Y.F. Huang**, M. Wang*. Analytical solution of inertia effect in high-speed flows through disordered porous media. *Physical Review Fluids*, **9**: L102101, 2024
9. Q.Q. Li, G. Yang, **Y.F. Huang**, X.K. Lu, J. Min and M. Wang*. Lattice Boltzmann method for particulate multiphase flow system. *International Journal of Mechanical Sciences*, **273**: 109217, 2024
10. Y.R. Li, **Y.F. Huang**, X.K. Lu, M. Wang*. Criterions of distribution transitions in dispersed multiphase systems based on an extended lattice model. *Langmuir*, **39**: 17021, 2023

✧ W. Liu, **Y.F. Huang**, M. Wang*. Flow transition triggered by strong capacitive charging near polarizable metal interfaces. *Journal of Fluid Mechanics*, 2025. *Under review*

✧ X.K. Lu, Q.Q. Li, G. Yang, **Y.F. Huang**, M. Wang*. Inertial accumulation effect on particle transport under low Stokes number and preferential flow control in disordered media. *Physical Review Fluids*, 2025 *Under review*

Journal papers (in Chinese)

11. **Y.F. Huang** and M. Wang*. Electrokinetics at liquid-liquid interfaces: Mechanisms and applications. ***Chinese Journal of Theoretical and Applied Mechanics***, 2025. *Under review* [in Chinese]
12. **Y.F. Huang**, M. Wang*. Merging of mechanics and mathematical physics: a brief discussion on similarity method. *Mechanics in Engineering*, **46**: 868-875, 2024 [in Chinese]
13. **Y.F. Huang**. Relationship between the two loci of instant center of rigid body in plane motion. *Mechanics in Engineering* **3**: 306, 2017 [in Chinese]
14. B. Liu, **Y.F. Huang**, M. Wang*. Physics and modeling of phonon wave behaviors in nanoscale heat conduction. ***Chinese Journal of Computational Physics***, **41**: 746, 2024 [in Chinese]

Conferences

1. **Y.F. Huang**, W. Liu, M. Wang*. Electrokinetic multiphase flow at spontaneously charged liquid-liquid interface: a diffuse interface model with adsorption-induced interface charge (Oral & Long abstract). *ICTAM 2024*. Daegu, Korea. 2024.08
2. **Y.F. Huang**, A. Alizadeh, F.L. Liu, M. Wang*. Measurement of surface charge at immiscible liquid-liquid interface using streaming-potential-on-microfluidics (Oral). *InterPore 2023*. Edinburgh, UK. 2023.05
3. **Y.F. Huang**, M. Wang*. Measurement of liquid-liquid interfacial charge based on streaming potential (Oral). *NCFluid 2022*. Xi'an, China. 2022.11 [in Chinese]
4. **Y.F. Huang**, M. Wang*. Hydrodynamics of low dimensional electron transport at micro-nanoscales (Oral & Paper). *CCTAM 2019*. Hangzhou, China. 2019.08 [in Chinese]

✧ **Y.F. Huang**, M. Wang*. Ion concentration polarization effect in electrophoresis of highly charged dielectric droplet (Oral). *CCTAM 2025*. Changsha, China. 2025.08. *Under review* [in Chinese]

Patents (Chinese)

1. M. Wang, **Y.F. Huang** and F.L. Liu. A method and apparatus for measuring the charge density at the liquid-liquid interface, patent number ZL 2021 1 1448254.6, authorization number CN 114216950 B, 2024.
2. M. Wang, **Y.F. Huang**. A method, device, and system for in-situ measurement of the charge density at the immiscible liquid interface, application number 012434465, 2024.

Software copyrights (Chinese)

3. M. Wang, G, Yang, H.Y. Chen, and **Y.F. Huang**. Multi-physics, multi-phase, multi-scale flow simulation software (μ^3-Flows), registration number 2024SR0160474, 2024.