

Lu Zhu, Ph.D., Research Associate

Dept. of Applied Mathematics and Theoretical Physics, University of Cambridge

Email: lz447@cam.ac.uk

Phone: +44 (752)2112769

Address: Wilberforce Road, Cambridge, CB3 0WA, the United Kingdom

[Website](#), [ResearchGate](#), [GoogleScholar](#)

Research Interests

Computational fluid dynamics; Polymer materials; Stratified flows; Complex fluids and flows; Turbulence; Hydraulic modeling, Artificial Intelligence; Optimization; High performance computing.

Education

Chemical Engineering, McMaster University (09/2015-08/2019)

Degree: Ph.D.

Supervisor: Dr. Li Xi

Key Words: CFD, turbulence, polymer additives drag reduction, vortex tracking

Focus:

- Studied drag reduction phenomenon in polymeric turbulence using direct numerical simulation (DNS) and proposed theoretical explanation.
- Developed a hybrid method to suppress numerical oscillations in pseudo-spectral DNS.
- Designed vortex tracking scheme for the analysis of vortex configuration and dynamics.
- Investigated dynamics of elastic instabilities in highly elastic polymeric flows.

Main Courses: Introduction of Turbulent Flow, Parallel and High-Performance Computing, Polymer Physics, Optimization of Chemical Processes, Neural Network and Development Tool, Deep Learning and Applications

Fluid Machinery and Engineering, East China Univ. of Sci. and Tech. (09/2012-06/2015)

Degree: M. Sci.

Supervisor: Prof. Huanxin Lai

Key words: Galvanizing zinc pot, multi-physics coupling system, CFD

Focus:

- Delivered multi-physics models coupling the electromagnetic, thermal and flow dynamics for an industry galvanizing zinc pot.
- Explored parameter spaces for the optimal operation condition for high-performance coating.

Main Courses: Computational Fluid Dynamics, Advanced Thermodynamics

Mechanical and Power Engineering, East China Univ. of Sci. and Tech. (09/2008-06/2012)

Degree: B. Eng.

Majored in Progress Equipment and Control Engineering

Main Courses: Engineering Fluid Mechanics, Mechanical Design, Machinery Principles

Employment

Research Associate@ DAMTP, University of Cambridge (12/2023-present)

- Working with Prof. Rich Kerswell.
- Implementing numerical simulation of polymeric flows in porous media.
- Using global stability analysis to investigate linear instabilities of polymeric flows.

Research Associate@ DAMTP, University of Cambridge (05/2021-12/2023)

- Working with Prof. Paul F. Linden and Prof. Rich Kerswell.
- Numerically simulating flows in a stratified inclined duct.
- Developing multi-layer hydraulic models to investigate the turbulence transition of stratified flows.
- Applying physics-informed machine learning to reconstruct stratified flow field from numerical and experimental data.

Postdoc Fellow@ Chemical Engineering, McMaster University (05/2020-05/2021)

- Funded by Mitacs Accelerate Program, Worked with Prof. Prashant Mhaskar and Dr. Li Xi.
- Developed CFD and crystallization kinetic models to model industrial crystallization reactors.
- Optimized the operation conditions of industry reactors with Genetic Algorithm.
- Investigated crystal defects in industry reactors and guided industrial scale-up.

Postdoc Research Assistant@ Chemical Engineering, McMaster University (10/2019-05/2020)

- Supervised by Dr. Li Xi
- Studied the dynamics of elastoinertial turbulence in channel flows with DNS.

Teaching Experience

Graduate Teaching Assistant@ Chemical Engineering, McMaster University (2015-2019)

- Level 2 course, CHEMENG 2004: Fluid Mechanics
- Delivered tutorial sessions for groups of up to 150 undergraduate students.
- Responsible for organization and delivery of sessions and course work marking and feedback.

Mentor/Supervisor@ Chemical Engineering, McMaster University (2016-2020)

- Supervised summer internship of 6 undergraduate students.
- Responsible for prior-assessment of curriculum, training interns in theoretical and practical technologies, helping interns to run their simulations and analyze the results.

Publications

Published/Accepted:

1. **Zhu, L.***, Atoufi, A., Lefauve, A., Kerswell, R. R., Linden, P. F. (2024). Long-wave instabilities of sloping stratified exchange flows. *Accepted by J. Fluid Mech.*
2. **Zhu, L.***, Jiang, X., Lefauve, A., Kerswell, R. R., Linden, P. F. (2024). New insights into experimental stratified flows obtained through physics-informed neural networks. *J. Fluid Mech*, 981, R1. ([link](#))
3. Atoufi, A, **Zhu, L.***, et. al. (2023), Stratified inclined duct: two-layer hydraulics and instability. *J. Fluid Mech.*, 977, A25. ([link](#))
4. **Zhu, L.**, et. al. (2023), Stratified inclined duct: direct numerical simulations. *J. Fluid Mech.*, 969, A20. ([link](#))
5. Zhang, Q., Zhang, F., Erfani, T., & **Zhu, L.*** (2023). Bagged stepwise cluster analysis for probabilistic river flow prediction. *J. Hydrol.*, 625, 129995. ([link](#))
6. **Zhu, L.** & Xi, L. (2021). Non-asymptotic elastoinertial turbulence for asymptotic drag reduction. *Phys. Rev. Fluids*, 014601. ([link](#))
7. **Zhu, L.** & Xi, L. (2020). Inertia-driven and elastoinertial viscoelastic turbulent channel flow simulated with a hybrid pseudo-spectral/finite-difference numerical scheme. *J. Non-Newton. Fluid Mech*, 286: 104410. ([link](#))
8. **Zhu, L.** & Xi, L. (2019). Vortex dynamics in low- and high-extent polymer drag reduction regimes revealed by vortex tracking and conformation analysis. *Phys. Fluids*, 31(9), 095103. ([link](#))
9. **Zhu, L.** & Xi, L. (2019). Vortex axis tracking by iterative propagation (VATIP): A method for analysing three-dimensional turbulent structures. *J. Fluid Mech.*, 866, 169-215. ([link](#))
10. **Zhu, L.** et. al. (2019). Transient dynamics of turbulence growth and bursting: Effects of drag-reducing polymers. *J. Non-Newton. Fluid Mech.*, 266, 127-142. ([link](#))
11. **Zhu, L.**, et. al. (2018). Distinct transition in flow statistics and vortex dynamics between low-and high-extent turbulent drag reduction in polymer fluids. *J. Non-Newton. Fluid Mech.*, 262, 115-130. ([link](#))
12. **Zhu, L.** & Xi, L. (2018). Coherent structure dynamics and identification during the multistage transitions of polymeric turbulent channel flow. *J. Phys.: Conf. Ser.* 1001. ([link](#))
13. **Zhu, L.** et.al. (2014). Calculation of the Coupled Electromagnetic and Flow-Fields in a Hot Dip Galvanizing Bath. *J.ECUST (in Chinese)*. 4: 533-538.
14. Jiang, X., Atoufi, A., **Zhu, L.**, et al (2023). Geometry of stratified turbulent mixing: local alignment of the density gradient with rotation, shear and viscous dissipation. *J. Fluid Mech*, 2023;977:R5.
15. McKay, A., Ghosh D., **Zhu, L.**, et. al. (2022), A Novel Linear Hybrid Model Predictive Control Design: Application to a Fed Batch Crystallization Process. *Digital Chemical Engineering*. 100033.
16. Zhang, Q., Li, Z., **Zhu, L.**, et al. (2021). Real-time prediction of river chloride concentration using

ensemble learning. *Environ. Pollut.*, 291, 118116. ([link](#))

17. **Zhu, L.** et al. (2023) ‘Research data supporting ‘Stratified inclined duct: direct numerical simulations’’. Apollo - University of Cambridge Repository. ([link](#))

Under review/preparation:

1. **Zhu, L.** & Xi, L. (2024). Direct transition to elastoinertial turbulence from a linear instability in channel flow. *Submitted to JFM*.
2. Atoufi, A, **Zhu, L.***, Lefauve, A., Taylor, J., Kerswell, R., Dalziel, S., Lawrence G., and Linden P. (2024), Stratified inclined duct: three-layer hydraulics. *Under preparation*.
3. Zhu, L., et. al. (2024). Reactive crystallization of Ulotaront hydrochloride with solution-mediated polymorphic transformation: Particle size control and process scale-up. *Under preparation*.

Conferences and Presentations

1. **Zhu, L.** et.al. New insights into experimental stratified flows obtained through physics-informed neural networks. **Fluid Mechanics Seminars** (Invited), Feb 2024, Cambridge, UK.
2. **Zhu, L.** et.al. Numerical investigation of laminar-turbulence transition in stratified inclined ducts. **IX International Symposium on Stratified Flows**. Aug 2022, Cambridge, UK
3. **Zhu, L.** & Xi, L. Vortex axis tracking by iterative propagation (VATIP): analyzing three-dimensional vortex structures in viscous and viscoelastic turbulent flows. **2019 APS March Meeting**, Mar. 2019, Boston, MA, Unite States
4. **Zhu, L.** & Xi, L. Vortex dynamics for high levels of drag reduction: quantitative analysis enabled by a new vortex tracking algorithm. **2018 AIChE Annual Meeting**, Oct. 2018, Pittsburgh, PA, Unite States
5. **Zhu, L.** & Xi, L. Vortex dynamics for high levels of drag reduction: quantitative analysis enabled by a new vortex tracking algorithm. **The Society of Rheology 90th Annual Meeting**, Oct. 2018, Houston, TX, Unite States
6. **Zhu, L.** & Xi, L. Polymer-turbulence interactions and vortex dynamics in polymer additives turbulent channel flow. **67th Canadian Chemical Engineering Conf.**, Oct. 2017, Edmonton, AB, Canada

Academic activities

Session chair, IX International Symposium on Stratified Flows, Cambridge, UK (2022)

Peer review, Journal of Fluid Mechanics, reviewed articles on complex fluids (03/2023-present)

Peer review, Physics of Fluids, reviewed articles on turbulent mechanism (07/2020-present)

Peer review, AIP Advances, reviewed articles on turbulent dynamics (02/2019-present)

Peer review, Fluid Dynamics Research, reviewed articles on CFD (02/2019-present)

Participant, 3rd Madrid Turbulence Workshop, hosted by Prof. Javier Jiménez, Madrid, Spain

(05/2017-06/2017)

Participant, Compute Ontario HPC Summer School, Hamilton, Canada (05/2016-06/2016)

Honor and Awards

- ✧ Mitacs Postdoc Fellowship (60,000CAD), Mitacs, 2020
- ✧ NSERC PhD Studentship (80,000CAD), McMaster University, 2015
- ✧ GSA Travel Award (1,000CAD), McMaster University, 2017 & 2019
- ✧ Chinese National Graduate Scholarship (20,000RMB), Ministry of Education of China, 2014
- ✧ Outstanding Student in Science and Engineering of ECUST, ECUST, 2012