

Wei SU

Assistant Professor

Division of Emerging Interdisciplinary Areas
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RESEARCH SUMMARY

- My research focuses on computational rarefied gas dynamics, aiming to develop accurate and efficient numerical models and methods for kinetic equations and multiscale simulations.
- I have been applying my computational models and methods in a variety of engineering applications, e.g., micro/nano-flows, porous media flows, high-altitude flights, lyophilisation and vacuum technologies.
- I am also interested in sophisticated modelling of non-equilibrium relaxation in shock-heated flows, occurring in the context of space exploration.
- My long-term research goal is to establish a powerful multiscale computational tool to boost the development of emerging technologies.

EDUCATION

PhD. Eng. <i>Aerospace Propulsion Theory and Engineering</i> Beihang University	2015 <i>China</i>
BSc. Eng. <i>Aerospace Power Engineering</i> Beihang University	2008 <i>China</i>
Undergraduate Training Program <i>Computer Aided Engineering and Design</i> Ecole Supérieure des Techniques Aéronautiques et de Construction Automobile	2008 <i>France</i>

EXPERIENCES

Assistant Professor Division of Emerging Interdisciplinary Areas, The Hong Kong University of Science & Technology <i>HK</i>	08/2022 - present
Research Associate Institute for Multiscale Thermofluids, The University of Edinburgh	10/2020 - 08/2022 <i>UK</i>
Research Associate Department of Mechanical & Aerospace Engineering, University of Strathclyde	10/2018 - 09/2020 <i>UK</i>
Visiting Researcher Department of Mechanical & Aerospace Engineering, University of Strathclyde	10/2017 - 09/2018 <i>UK</i>
Postdoctoral Researcher Institute of Nanotechnology, National Research Council	11/2015 - 11/2016 <i>Italy</i>
Visiting PhD Student School of Aeronautics & Astronautics, Purdue University	09/2011 - 09/2012 <i>USA</i>

AWARDS

ICMMES-CSRC Award for Recent PhD Recipients 17 th International Conference for Mesoscopic Methods in Engineering & Science	2020
Innovative Award for Young Researchers Symposium on 'Modelling & Numerical Methods for Nonequilibrium Transport Problem'	2019

Postdoc Mobility Travel Grant of Technical University of Munich Travel fellowship for 50 (out of 273) attendees in 'Research Opportunity Week'	2017
National Scholarship Chinese national scholarship for the top 0.2% postgraduate students	2012
International Scholarship of Chinese Scholarship Council Support my one-year visit at Purdue University	2011
Oversea Scholarship of Beihang University Support my half-year training at ESTACA	2008
Outstanding Student Award of China Aerospace Science & Technology Corporation Third-class industrial scholarship	2007
Outstanding Academic Performance Award of Beihang University First-class scholarship for outstanding academic performance	2005/2006/2007
Outstanding Student Award of Shanghai Baosteel Group Corporation Third-class industrial scholarship	2005

GRANTS

National Science Foundation for Young Scientists <i>Chinese Government</i>	01/2014 – 12/2016 <i>Beijing, China</i>
<ul style="list-style-type: none"> · £30,000, Co-I · Topic: 'The direct numerical simulation of Boltzmann model equations based on high-order Runge-Kutta discontinuous Galerkin method' · I participated in generating research idea, writing the proposal and conducting research. 	
Innovation Foundation for Postgraduate Students <i>Beihang University</i>	09/2010 – 08/2011 <i>Beijing, China</i>
<ul style="list-style-type: none"> · £1,500, PI · Topic: 'Extension of the low diffusion particle method in simulating near continuum two-phase flow' · I successfully obtained this personal grant to support my research. 	

UNDERGRADUATE TEACHING AND SUPERVISION

4th-Year Undergraduate Project <i>School of Engineering, The University of Edinburgh</i>	AY20/21, AY21/22 <i>Edinburgh, UK</i>
<ul style="list-style-type: none"> · Topic: 'Heat conduction of rarefied gas through porous media' · I generated the research topic and co-supervised the day-to-day research activity. 	
Undergraduate Teaching <i>Mechanical & Aerospace Engineering, University of Strathclyde</i>	AY18/19, AY19/20 <i>Glasgow, UK</i>
<ul style="list-style-type: none"> · Course: ME107/EF016 Experimental and Laboratory Skills: Wind Tunnel · Served as the instructor, I independently ran the lab by preparing materials, instructing and assessing, grading assignments, and communicating with students and the department. 	
Undergraduate Teaching <i>Mechanical & Aerospace Engineering, University of Strathclyde</i>	AY18/19, AY19/20 <i>Glasgow, UK</i>
<ul style="list-style-type: none"> · Course: ME301 Heat Transfer & Thermodynamics · Served as a tutor, I led tutorials and graded examinations. 	
4th-Year Undergraduate Projects <i>Mechanical & Aerospace Engineering, University of Strathclyde</i>	AY18/19 <i>Glasgow, UK</i>
<ul style="list-style-type: none"> · Topic 1: 'The rarefied gas properties of porous media constructed by Sierpinski carpet and channel with rectangular obstacles' 	

- Topic 2: ‘Investigation of gas flow through fractal structures’
- Topic 3: ‘Investigation of rarefied gas flows through 2D bifurcating channels using the BGK model of the Boltzmann equation’
- I co-supervised the day-to-day research activities.
- The project 3 was awarded the Best Project Award of Institute of Mechanical Engineers.

4th-Year Undergraduate Project

AY14/15

School of Astronautic, Beihang University

Beijing, China

- Topic: ‘RKDG based adaptive mesh for 1D Boltzmann kinetic model equation’
- As the mentor, I generated the topic from my PhD research and conducted day-to-day supervision.
- This project was awarded *the Excellent Project Award* in the School of Astronautics.

PUBLICATIONS

* corresponding author

Peer-Reviewed Journals

- [1] J Liu, C Zhang, H Yuan, **W Su***, L Wu (2022). A fast-converging scheme for the phonon Boltzmann equation with dual relaxation times. *Journal of Computational Physics*. 467: 111436. [10.1016/j.jcp.2022.111436](https://doi.org/10.1016/j.jcp.2022.111436)
- [2] **W Su**, Q Li, Y Zhang, L Wu (2022). Temperature jump and Knudsen layer in rarefied molecular gas. *Physics of Fluids*. 34: 032010. [10.1063/5.0086076](https://doi.org/10.1063/5.0086076)
- [3] **W Su**, Y Zhang, L Wu (2021). Multiscale simulation of molecular gas flows by the general synthetic iterative scheme. *Computer Methods in Applied Mechanics and Engineering*. 373: 113548. [10.1016/j.cma.2020.113548](https://doi.org/10.1016/j.cma.2020.113548)
- [4] Q Li, J Zeng, **W Su**, L Wu (2021). Uncertainty quantification in rarefied dynamics of molecular gas: rate effect of thermal relaxation. *Journal of Fluid Mechanics*. 917: A58. [10.1017/jfm.2021.338](https://doi.org/10.1017/jfm.2021.338)
- [5] L Zhu, X Pi, **W Su**, Z Li, Y Zhang, L Wu (2021). General synthetic iterative scheme for nonlinear gas kinetic simulation of multi-scale rarefied gas flows. *Journal of Computational Physics*. 430: 110091. [10.1016/j.jcp.2020.110091](https://doi.org/10.1016/j.jcp.2020.110091)
- [6] **W Su**, L Zhu, L Wu (2020). Fast convergence and asymptotic preserving of the general synthetic iterative scheme. *SIAM Journal on Scientific Computing*. 42(6): B1517-B1540. [10.1137/20M132691X](https://doi.org/10.1137/20M132691X)
- [7] P Wang, **W Su**, L Wu (2020). Thermal transpiration in molecular gas. *Physics of Fluids*, 32: 082005. [10.1063/5.0018505](https://doi.org/10.1063/5.0018505)
- [8] **W Su**, M T Ho, Y Zhang, L Wu (2020). GSIS: an efficient and accurate numerical method to obtain the apparent gas permeability of porous media. *Computers & Fluids*, 206: 104576. [10.1016/j.compfluid.2020.104576](https://doi.org/10.1016/j.compfluid.2020.104576)
- [9] M T Ho, J Li, **W Su**, L Wu, M Borg, Y Zhang (2020). Rarefied flow separation in microchannel with bends. *Journal of Fluid Mechanics*, 901: A26. [10.1017/jfm.2020.585](https://doi.org/10.1017/jfm.2020.585)
- [10] **W Su**, P Wang, Y Zhang, L Wu (2020). Implicit discontinuous Galerkin method for the Boltzmann equation with full collision operator. *Journal of Scientific Computing*, 82: 39. [10.1007/s10915-020-01139-7](https://doi.org/10.1007/s10915-020-01139-7)
- [11] **W Su**, L Zhu, P Wang, Y Zhang, L Wu (2020). Can we find steady-state solutions to multiscale rarefied gas flows within dozens of iterations? *Journal of Computational Physics*, 407: 109245. [10.1016/j.jcp.2020.109245](https://doi.org/10.1016/j.jcp.2020.109245)
- [12] **W Su***, P Wang, Y Zhang (2019). High-order hybridizable discontinuous Galerkin method for the gas kinetic equation. *International Journal of Computational Fluid Dynamics*, 33: 335-342. [10.1080/10618562.2019.1666110](https://doi.org/10.1080/10618562.2019.1666110) (On the special issue of ‘Discontinuous Galerkin methods: new trends and applications’)
- [13] P Wang, **W Su**, L Zhu, Y Zhang (2019). Heat and mass transfer of oscillatory lid-driven flow in the continuum, transition and free molecular flow regimes. *International Journal of Heat and Mass Transfer*, 131: 291-300. [10.1016/j.ijheatmasstransfer.2018.11.060](https://doi.org/10.1016/j.ijheatmasstransfer.2018.11.060)

- [14] **W Su**, P Wang, H Liu, L Wu (2019). Accurate and efficient computation of the Boltzmann equation for Couette flow: influence of intermolecular potentials on Knudsen layer function and viscous slip coefficient. *Journal of Computational Physics*, 378: 573-590. [10.1016/j.jcp.2018.11.015](#)
- [15] **W Su**, P Wang, Y Zhang, L Wu (2019). A high-order hybridizable discontinuous Galerkin method with fast convergence to steady-state solutions of the gas kinetic equation. *Journal of Computational Physics*, 376: 973-991. [10.1016/j.jcp.2018.08.050](#)
- [16] P Wang, **W Su**, Y Zhang (2018). Oscillatory rarefied gas flow inside a three dimensional rectangular cavity. *Physics of Fluids*, 30: 102002. [10.1063/1.5052253](#)
- [17] **W Su**, D Bruno, Y Babou (2018). State-specific modeling of vibrational relaxation and nitric oxide formation in shock-heated air. *Journal of Thermophysics and Heat Transfer*, 32: 337-352. [10.2514/1.T5271](#)
- [18] W Liu, G Tang, **W Su**, L Wu, Y Zhang (2018). Rarefaction throttling effect: Influence of the bend in micro-channel gaseous flow. *Physics of Fluids*, 30: 082002. [10.1063/1.5037430](#)
- [19] P Wang, L Zhu, **W Su**, L Wu, Y Zhang (2018). Nonlinear oscillatory rarefied gas flow inside a rectangular cavity. *Physical Review E*, 97: 043103. [10.1103/PhysRevE.97.043103](#)
- [20] **W Su**, H Liu, Y Zhang, L Wu (2017). Rarefaction cloaking: Influence of the fractal rough surface in gas slider bearings. *Physics of Fluids*, 29: 102003. [10.1063/1.4999696](#)
- [21] **W Su**, S Lindsay, H Liu, L Wu (2017). Comparative study of the discrete velocity and lattice Boltzmann methods for rarefied gas flows through irregular channels. *Physical Review E*, 96: 023309. [10.1103/PhysRevE.96.023309](#)
- [22] **W Su**, Z Tang, B He, G Cai (2017). Stable Runge-Kutta discontinuous Galerkin solver for hypersonic rarefied gaseous flows based on 2D Boltzmann kinetic equations. *Applied Mathematics and Mechanics*, 38: 343-362. [10.1007/s10483-017-2177-8](#)
- [23] **W Su**, A Alexeenko, G Cai (2015). A parallel Runge-Kutta discontinuous Galerkin solver for rarefied gas flows based on 2D Boltzmann kinetic equations. *Computers & Fluids*, 109: 123-136. [10.1016/j.compfluid.2014.12.015](#)
- [24] **W Su**, X He, G Cai (2013). Extension of the low diffusion particle method for near-continuum two-phase flow simulations. *Chinese Journal of Aeronautics*, 26: 37-46. [10.1016/j.cja.2012.12.010](#)
- [25] G Cai, **W Su**, F Hou (2012). Theoretical development for DSMC local time stepping technique. *Science China: Technological Sciences*, 55: 2750-2756. [10.1007/s11431-012-4913-7](#)

Preprints

- [26] **W Su**, L Gibelli, J Li, M K Borg, Y H Zhang. Kinetic modelling of non-equilibrium flow of hard-sphere dense gases. Submitted to *Journal of Fluid Mechanics*.
- [27] L Wu, **W Su**, J Zeng. General synthetic iterative scheme for unsteady rarefied gas flows. Submitted to *Journal of Computational Physics*.

Peer-Reviewed Conference Proceedings

- [28] **W Su**, D Bruno, Y Babou (2017). Investigations of vibrational kinetic relaxation within air shock wave plasma. *Journal of Physics: Conference Series*, 815: 012026. [10.1088/1742-6596/815/1/012026](#)
- [29] **W Su**, D Bruno, Y Babou (2016). Vibrational specific simulation of nonequilibrium radiation from shock-heated air. *AIP Conference Proceedings*, 1786: 150001. [10.1063/1.4967642](#)
- [30] **W Su**, B He, G Cai (2014). A stable Runge-Kutta discontinuous Galerkin solver for hypersonic rarefied gaseous flows. *AIP Conference Proceedings*, 1628: 980-987. [10.1063/1.4902700](#)
- [31] **W Su**, A Alexeenko, G Cai (2012). A Runge-Kutta discontinuous Galerkin solver for 2D Boltzmann model equations: verification and analysis of computational performance. *AIP Conference Proceedings*, 1501: 381-388. [10.1063/1.4769547](#)

Posters

- [32] **W Su**, M T Ho, Y H Zhang, L Wu (2021). Multiscale simulation of gas transport in porous media. *25th International Congress of Theoretical and Applied Mechanics*, August 2021, online.

- [33] **W Su**, P Wang, Y H Zhang, L Wu (2018). High-order hybridizable discontinuous Galerkin method for the gas kinetic equation. *30th International Symposium on Rarefied Gas Dynamics*, July 2018, Glasgow, UK

TALKS

‡ Invited talk, § keynote

- 1[‡]. ‘Heat conduction of rarefied gas in porous media’, *32th International Symposium on Rarefied Gas Dynamics*, 07/2022, Seoul, Korean.
- 2[§]. ‘General synthetic iterative scheme for multiscale rarefied gas’, *17th International Conference for Mesoscopic Methods in Engineering & Science*, 07/2021, online.
- 3[‡]. ‘Fast converging and asymptotic preserving method for multiscale rarefied gas flows’, *International Workshop and Summer School on Kinetic Theory and Related Application, Beijing Computational Science Research Center*, 06/2021, online.
- 4[‡]. ‘GSIS: efficient and accurate methods for multiscale rarefied gas flows’, *Academic Salons for Young Researchers, Chinese Society of Theoretical and Applied Mechanics*, 05/2021, online.
- 5[‡]. ‘Multiscale simulation of gas transport in porous media’, *5th International Conference on Digital Core Analysis & The Workshop on Multiscale Numerical and Experimental Approaches for Multiphysics Problems in Porous Media*, 04/2021, online.
6. ‘Fast convergence and asymptotic preserving discontinuous Galerkin method for gas kinetic equation’, *14th World Congress in Computational Mechanics & ECCOMAS Congress*, 01/2021, online.
7. ‘Multiscale simulation of rarefied gas dynamics by the general synthetic iterative scheme’, *2020 International Workshop of UK Consortium on Mesoscale Engineering Sciences*, 12/2020, online.
8. ‘Multiscale simulation of gas dynamics beyond Navier-Stokes limit’, *Seminar series of Institute for Multiscale Thermofluids*, 12/2020, University of Edinburgh, Edinburgh, UK.
9. ‘Solving the gas kinetic equation using synthetic iteration method’, *9th International Congress on Industrial and Applied Mathematics*, 07/2019, Valencia, Spain.
10. ‘Can we find steady-state solutions to multiscale rarefied gas flows within dozens of iterations?’, *3th Symposium on Modelling and Numerical Methods for Non-Equilibrium Transport Problem*, 06/2019, Xi’an, China.
11. ‘A high-order hybridizable discontinuous Galerkin method for gas kinetic equation’, *7th European Conference on Computational Fluid Dynamics*, 06/2018, Glasgow, UK.
- 12[‡]. ‘Solving Boltzmann model equations with high-order Runge-Kutta discontinuous Galerkin method’, *Academic visit in School of Energy and Power Engineering of Xi’an Jiaotong University*, 10/2017, Xi’an China.
13. ‘Investigations of vibrational kinetic relaxation within air shock wave plasma’, *7th International Workshop on Radiation of High Temperature Gases in Atmospheric Entry*, 09/2016, Stuttgart, Germany.
14. ‘Vibrational specific simulation of nonequilibrium radiation from shock-heated air’, *30th International Symposium on Rarefied Gas Dynamics*, 07/2016, Victoria BC, Canada.
15. ‘A stable Runge-Kutta discontinuous Galerkin solver for hypersonic rarefied gaseous flows’, *29th International Symposium on Rarefied Gas Dynamics*, 07/2014, Xi’an, China.
16. ‘A Runge-Kutta discontinuous Galerkin solver for 2D Boltzmann model equations’, *28th International Symposium on Rarefied Gas Dynamics*, 07/2012, Zaragoza, Spain.

INDUSTRIAL PROJECTS

Chinese Academy of Space Technology

2009 – 2013

Beijing, China

- Project 1: ‘Numerical and experimental analysis on the plume effects of CHANG’E-III main thruster during its landing’

- Project 2: ‘Numerical simulation on the plume effects of SHENZHOU-VIII spacecraft on TIANGONG-I space lab during docking and separating’
- Project 3: ‘Numerical study on the plume effects of a satellite’s thrusters’
- I involved in Project 1&2 as one of the main participants through intensive group work with colleagues, professors and experts from industry.
- As the student leader, I communicated with the industrial partner and led a group of 3 undergraduate students to complete Project 3.

SERVICES

Peer-Review for Journals

2014 – present

Journal of Computational Physics/X, Journal of Fluid Mechanics, Physics of Fluids, Computer & Fluids, Vacuum, Advanced in Applied Mathematics and Mechanics, International Journal of Computational Fluid Dynamics

Citizenship

- **04/2021 – 08/2022**, External Liaison Officer & Committee Member in **Molly Fergusson Initiative** of the University of Edinburgh. We aim to encourage people that identify as women in Engineering by highlighting the incredible achievements of women through the ages and networking with current female engineers.
- **09/2005 – 06/2008**, Consultant to help first-year students integrating into the new environment, Beihang University.

Voluntary

- **07/2009**, Coordinator for International Postgraduate Summer School in Aeronautics & Astronautics, Beihang University.