# Dr. Kunlun Qi

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CONTACT
INFORMATION

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RESEARCH
INTERESTS

**Multiscale modeling**: Kinetic limit of many-particle system, hydrodynamic limit of kinetic models, semi-classical limit of quantum system;

**Theoretical analysis for kinetic equations**: Well-posedness and asymptotic behavior of Boltzmann equation and its related models via Fourier approach;

**Numerical methods for kinetic equations**: Fourier-Spectral methods and fast algorithms for kinetic equations with stability/convergence analysis;

**Data-driven and machine-learning based methods**: Data assimilation, uncertainty quantification (UQ) and machine-learning moments closure model.

EMPLOYMENT

**School of Mathematics, University of Minnesota – Twin Cities**

Dunham Jackson Assistant Professor, August 2022 -

- Mentors: Prof. Li Wang, Prof. Mitchell Luskin, Prof. Alex Watson (Math)
  Prof. Richard D. James (Aerospace Engineering and Mechanics)

**Department of Mathematics, The Chinese University of Hong Kong**

Postdoctoral Fellow, July 2021 - July 2022

- Mentor: Prof. Renjun Duan

EDUCATION

**Department of Mathematics, City University of Hong Kong**

Ph.D. in Mathematics, September 2017 - July 2021

- Supervisor: Prof. Tong Yang

**School of Mathematics, South China University of Technology**

B.Sc. in Mathematics, September 2013 - July 2017

- GPA: 3.85/4.0, Rank: 2/64
- Minor certificate in Computer Science
- Advisors: Prof. Changjiang Zhu and Prof. Huanyao Wen

PREPRINTS

[16] A fast Fourier spectral method for wave kinetic equation, *preprint upon request*, 2024.
with *Lian Shen* and *Li Wang*

[15] Machine learning-based moment closure model for the linearized semi-conductor Boltzmann equation with uncertainties, *submitted*, 2024.
with *Juntao Huang, Liu Liu* and *Jiayu Wan*
arXiv: 2412.01932.

[14] Continuous data assimilation for hydrodynamics: consistent discretization and application to moment recovery, *submitted*, 2024.
with *Jingcheng Lu, Li Wang* and *Jeff Calder*
arXiv: 2409.03872.

[13] From the Boltzmann equation for gas mixture to the two-fluid incompressible hydrodynamic system, *submitted*, 2024.
with *Zhendong Fang*
arXiv: 2408.03570.

[12] Radiative transport in a periodic structure with band crossings, *submitted*, 2024.
with *Li Wang* and *Alexander B. Watson*
arXiv: 2402.06828.

[11] The small Deborah number limit for the fluid-particle flows II: compressible case, *submitted*, 2024.
with *Zhendong Fang* and *Huanyao Wen*

[10] Global existence and moment creation for the inelastic Boltzmann equation for hard potentials without angular cutoff, *submitted*, 2023.
with *Jin Woo Jang*
arXiv: 2206.09636v2.

PUBLICATIONS

[9] On the kinetic description of the objective molecular dynamics, accepted by **SIAM Multiscale Model. Simul.**, 2024.
with *Richard D. James* and *Li Wang*
arXiv: 2307.16814.

[8] The small Deborah number limit for the fluid-particle flows I: incompressible case, **Math. Models Methods Appl. Sci. (M3AS)**, 12(34), 2024.
with *Zhendong Fang* and *Huanyao Wen*
DOI: 10.1142/S0218202524500489.

[7] Convergence of the Fourier-Galerkin spectral method for the Boltzmann equation with uncertainties, **Commun. Math. Sci.**, 22(7), 1897-1925, 2024.
with *Liu Liu*
DOI: 10.4310/CMS.240918035418.

[6] Spectral convergence of a semi-discretized numerical system for the spatially homogeneous Boltzmann equation with uncertainties, **SIAM/ASA J. Uncertain. Quantif.**, 12(3), 812-841, 2024.
with *Liu Liu*
DOI: 10.1137/24M1638483.

[5] Measure valued solution to the spatially homogeneous Boltzmann equation with inelastic long-range interactions, **J. Math. Phys.**, 63, 021503, 2022.
DOI: 10.1063/5.0062859.

[4] A new stability and convergence proof of the Fourier-Galerkin spectral method for the spatially homogeneous Boltzmann equation, **SIAM J. Numer. Anal.**, 59(2), 613-633, 2021.
with *Jingwei Hu* and *Tong Yang*
DOI: 10.1137/20M1351813.

[3] On the measure valued solution to the inelastic Boltzmann equation with soft potentials, **J. Stat. Phys.**, 183, 27, 2021.
DOI: 10.1007/s10955-021-02762-w.

[2] A fast Fourier spectral method for the homogeneous Boltzmann equation with non-cutoff collision kernels, **J. Comput. Phys.**, 423:109806, 2020.
with *Jingwei Hu*
DOI: 10.1016/j.jcp.2020.109806.

CONFERENCE
PROCEEDINGS

[1] Measure-valued Solution to the inelastic Boltzmann equation for hard potentials without angular cutoff, **Proceedings of the 32nd International Symposium on Rarefied**

**Gas Dynamics** (RGD32), **AIP Conf. Proc.**, 2996, 040008, 2024.
with *Jin Woo Jang*
DOI: 10.1063/5.0187383.

WORK
IN
PROGRESS

(With *Richard D. James* and *Li Wang*) An anisotropic rescaling velocity method for the homo-energetic Boltzmann equation.

(With *Juntao Huang*, *Liu Liu* and *Jiayu Wan*) On the machine-learning moments closure for the linear semiconductor Boltzmann equation.

(With *Ru-yu Lai*, *Li Wang* and *Lili Yan*) Inverse problem for the Cucker-Smale kinetic equation.

(With *Jin Woo Jang*, *Jae Yong Lee*, *Liu Liu* and *Zhengyi Zhu*) Machine-learning moments closure model for the multi-phase computations of the semiclassical limit of the Schrödinger equation.

(With *Hao Jia*) Long-time behavior of the homo-energetic Boltzmann equation in the hyperbolic-dominated case.

(With *Dingqun Deng* and *Renjun Duan*) Homo-energetic solution to Boltzmann equation with infinite energy in probability measure space.

HONORS
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AWARDS

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| 2023 | **SIAM Early Career Travel Award**<br>Society for Industrial and Applied Mathematics (SIAM) and National Science Foundation (NSF) |
| 2023-2024 | **UMN Postdoc Award (Honorable Mention)** for Impactful Research<br>University of Minnesota |
| 2022 | **Hong Kong Mathematical Society Best Thesis Award**<br>Hong Kong Mathematical Society |
| 2019 | **Outstanding Teaching Award** for Teaching Assistants<br>City University of Hong Kong |
| 2017-2021 | **UGC-funded Postgraduate Scholarship**<br>The University Grants Committee of Hong Kong |
| 2016 | **Top 10 Outstanding Student at SCUT (Highest Student Award)**<br>South China University of Technology |
| 2016 | **National Scholarship**<br>Ministry of Education of China |
| 2016 | **First Prize in the Chinese Undergraduate Mathematics Competition (Guangdong Division)**<br>Chinese Mathematical Society |
| 2015 | **Samsung Scholarship**<br>Samsung China HQ |

SERVICES

Reviewer for Academic Journals: *Kinetic and Related Models (KRM)*, *Communications in Computational Physics (CiCP)*, *Applied Mathematics Letters (AML)*.

Conferences Organization: organizer of mini-symposium *"On the Interplay between Kinetic Theory and Quantum Dynamics"* at 10th International Congress on Industrial and Applied Mathematics (ICIAM2023).

Seminars and Workshops Organization: assistant organizer of weekly *"Applied and Computational Mathematics Seminar"* and *"New Trends in Kinetic and Optimal Transport Workshop"* at University of Minnesota.

Mini-course and Summer School Organization: lecturer and assistant organizer of *"MATH-*

*IMS mini-course in Boltzmann Equation"* at The Chinese University of Hong Kong.

Committee Service: DEI Committee member in the School of Mathematics at University of Minnesota.

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| **ACADEMIC VISITS** | *The Chinese University of Hong Kong*, Hong Kong, May 20 - June 24, 2024. |

*The Chinese University of Hong Kong*, Hong Kong, May 20 - June 24, 2024.

*University of Washington*, Seattle, USA, May 16 - 19, 2024.

*Tsinghua University*, Beijing, China, August 2 - 5, 2023.

*South China University of Technology*, Guangzhou, China, July 30 - August 2, 2023.

*The Chinese University of Hong Kong*, Hong Kong, July 23 - 28, 2023.

*University of Oslo*, Oslo, Norway, March 5 - 9, 2023.

*TU Delft*, Delft, The Netherlands, March 1 - 3, 2023.

*RWTH Aachen University*, Aachen, Germany, February 21 - 26, 2023.

**INVITED AND CONTRIBUTED TALKS**

*Webinar Kinetic and fluid equations for collective behavior*, December 2023, French-Korean IRL in Mathematics International Research Laboratory. (Virtual).

*6th Annual Meeting of the SIAM Texas-Louisiana Section*, November 2023, University of Louisiana at Lafayette, Lafayette, Louisiana, USA.

*New Trends in Kinetic and Optimal Transport Workshop*, October 2023, University of Minnesota – Twin Cities, Minneapolis, Minnesota, USA.

*The 8th Annual Meeting of SIAM Central States Section*, October 2023, University of Nebraska – Lincoln, Lincoln, Nebraska, USA.

*PDE Seminar*, September 2023, University of Minnesota – Twin Cities, Minneapolis, Minnesota, USA.

*Mini-symposium at the second HKSIAM Biennial conference*, August-September 2023, The Chinese University of Hong Kong, Hong Kong.

*Mini-symposium at 10th International Congress on Industrial and Applied Mathematics (ICIAM2023)*, August 2023, Waseda University, Tokyo, Japan.

*Midwest Numerical Analysis Day*, April 2023, Iowa State University, Ames, Iowa, USA.

*Seminar on Computational Mathematics*, March 2023, University of Oslo - Department of Mathematics, Oslo, Norway.

*Seminar in PDE and Applications*, March 2023, TU Delft - Delft Institute of Applied Mathematics, Delft, The Netherlands.

*Weekly Seminar of DFG Energy, Entropy, and Dissipative Dynamics Group*, February 2023, RWTH Aachen University, Aachen, Germany.

*The 6th Conference on Nonlinear Partial Differential Equation from Fluid Dynamic*, November 2022, Ningbo University, Ningbo, China. (Virtual)

*Analysis and PDE Seminar*, July 2022, South China University of Technology (SCUT), Guangzhou, China.

*Modelling and Numerical Simulation of Non-Equilibrium Processes Workshop*, January 2022, Institute for Mathematical Sciences, NUS, Singapore. (Virtual)

*PDE and Scientific Computing Seminar*, October 2021, National University of Singapore, Singapore. (Virtual)

*International Conference for Nonlinear PDEs in Fluid Mechanics and Related Topics*, October 2021, Zhejiang Normal University, Jinhua, China. (Virtual)

*The Pre-32nd International Symposium on Rarefied Gas Dynamics (Pre-RGD32) online Workshop*, July 2021, Seoul, South Korea. (Virtual)

*The 5th Conference on Nonlinear Partial Differential Equation from Fluid Dynamic*, May 2021, Central China Normal University, Wuhan, China. (Virtual)

*Oberseminar Analysis*, December 2020, Hausdorff Center for Mathematics, University of Bonn, Germany. (Virtual)

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| Teaching Experience | Instructor at the University of Minnesota–Twin Cities, 2022 - Present: |

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| 2024 Fall | *MATH 5485 Numerical Methods I* |
| 2024 Spring | *MATH 4428 Mathematical Modeling - Section 001 and 002* |
| 2023 Fall | *MATH 5485 Numerical Methods I* |
| 2023 Spring | *MATH 5486 Numerical Methods II* |
| 2022 Fall | *MATH 5485 Numerical Methods I – Section 001 and 002* |

Lecturer at The Chinese University of Hong Kong, 2021 - 2022:

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| 2021/22 Term 1 | *MATH-IMS Mini-Course in Boltzmann Equation* |
| 2021/22 Term 2 | *MATH6042 Topics in Differential Equations II* |

Tutor at City University of Hong Kong, 2018 - 2021:

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| 2018/19 Semester A | *MA1200 Calculus and Basic Linear Algebra I* |
| 2018/19 Semester B | *MA1201 Calculus and Basic Linear Algebra II* |
| 2019/20 Semester A | *MA2172 Applied Statistics for Sciences and Engineering* |
| 2019/20 Semester B | *MA0101 Basic Engineering Mathematics I* |
| 2020/21 Semester A | *MA1300 Enhanced Calculus and Linear Algebra I* |

Teaching Assistant at City University of Hong Kong, 2018 - 2021:

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| 2019/20 Semester A | *MA8006 Functional Analysis and Applications* |
| 2019/20 Semester B | *MA3511 Ordinary Differential Equations* |
| 2020/21 Semester A | *MA8006 Functional Analysis and Applications* |

References

**Professor Tong Yang**, Chair Professor (Ph.D Supervisor)
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**Professor Philippe G. Ciarlet**, University Distinguished Professor
Department of Mathematics
City University of Hong Kong
Email: `mapgc@cityu.edu.hk`

**Professor Richard D. James**, Distinguished McKnight University Professor
Department of Aerospace Engineering and Mechanics
University of Minnesota
Email: `james@umn.edu`

**Professor Li Wang**, Associate Professor
School of Mathematics
University of Minnesota
Email: `liwang@umn.edu`

**Professor Jingwei Hu**, Professor
Department of Applied Mathematics

University of Washington
Email: hujw@uw.edu

**Professor Michael Herty**, Professor and Chair of Numerical Analysis
Institute of Applied Mathematics (IGPM)
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**Professor Bryan Mosher**, Professor and Director of Undergraduate Studies
(For teaching)
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