Junming DUAN

Humboldt Research Fellow

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Academic Positions

October 2023 – September 2025	**Humboldt Research Fellow** Fakultät für Mathematik und Informatik, Universität Würzburg, Germany *Host Professor: Prof. Dr. Christian Klingenberg*
September 2021 – September 2023	**Postdoctoral Researcher** MCSS, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland *Mentor: Prof. Jan S. Hesthaven*

Education

September 2016 - July 2021	**Ph.D. in Computational Mathematics** Peking University, China *Entropy stable numerical methods for special relativistic (magneto)hydrodynamics* *Advisor: Prof. Huazhong Tang*
September 2012 - July 2016	**B.Sc. in Information and Computing Science** Peking University, China

Research Interests

- Numerical methods for hyperbolic conservation laws
- Computational fluid dynamics
- High-order accurate numerical methods
- Structure-preserving methods
- Moving mesh methods
- Reduced-ordel modeling
- Data-driven methods and scientific machine learning

Research Publications

Journal Articles

1. J. Wang, **J.M. Duan**, Z.W. Ma, and W. Zhang, An adaptive moving mesh finite difference scheme for tokamak magneto-hydrodynamic simulations, accepted by ***Comput. Phys. Commun.***, 2023.
2. Z.H. Zhang, **J.M. Duan***, and H.Z. Tang, High-order accurate well-balanced energy stable adaptive moving mesh finite difference schemes for the shallow water equations with non-flat bottom topography, ***J. Comput. Phys.***, 492: 112451, 2023. *arXiv:2303.06924*.
3. S.T. Li, **J.M. Duan**, and H.Z. Tang, High-order accurate entropy stable adaptive moving mesh finite difference schemes for (multi-component) compressible Euler equations with the stiffened equation of state, ***Comput. Methods Appl. Mech. Engrg.***, 399: 115311, 2022. *arXiv:2202.07989*.
4. **J.M. Duan** and H.Z. Tang, High-order accurate entropy stable adaptive moving mesh finite difference schemes for special relativistic (magneto)hydrodynamics, ***J. Comput. Phys.***, 456: 111038, 2022. *arXiv:2107.12027*.
5. **J.M. Duan** and H.Z. Tang, An analytical solution of the isentropic vortex problem in the special relativistic magnetohydrodynamics, ***J. Comput. Phys.***, 456: 110903, 2022. *arXiv:2107.01966*.
6. **J.M. Duan** and H.Z. Tang, High-order accurate entropy stable finite difference schemes for the shallow water magnetohydrodynamics, ***J. Comput. Phys.***, 431: 110136, 2021. *arXiv:2003.10081*.
7. **J.M. Duan** and H.Z. Tang, Entropy stable adaptive moving mesh schemes for 2D and 3D special relativistic hydrodynamics, ***J. Comput. Phys.***, 426: 109949, 2021. *arXiv:2007.12884*.
8. **J.M. Duan** and H.Z. Tang, High-order accurate entropy stable nodal discontinuous Galerkin schemes for the ideal special relativistic magnetohydrodynamics, ***J. Comput. Phys.***, 421: 109731, 2020. *arXiv:1911.03825*.

9. **J.M. Duan** and H.Z. Tang, High-order accurate entropy stable finite difference schemes for one- and two-dimensional special relativistic hydrodynamics, ***Adv. Appl. Math. Mech.***, 12(1): 1-29, 2020. *arXiv:1905.06092*.
10. **J.M. Duan** and H.Z. Tang, An efficient ADER discontinuous Galerkin scheme for directly solving Hamilton-Jacobi equation, ***J. Comput. Math.***, 38(1): 58-83, 2020. *arXiv:1901.10228*.
11. D. Ling, **J.M. Duan**, and H.Z. Tang, Physical-constraints-preserving Lagrangian finite volume schemes for one- and two-dimensional special relativistic hydrodynamics, ***J. Comput. Phys.***, 396: 507-543, 2019. *arXiv:1901.10625*.
12. **J.M. Duan** and H.Z. Tang, A second-order accurate scheme for a kinetic equation of two-dimensional Vicsek swarming model, ***Nat. Sci. J. Xiangtan Univ.***, 41(1): 1-14, 2019. (in Chinese)
13. **J.M. Duan**, Y.Y. Kuang, and H.Z. Tang, Model reduction of a two-dimensional kinetic swarming model by operator projections, ***East Asian J. Appl. Math.***, 8(1): 151-180, 2018. *arXiv:1701.02888*.

PREPRINTS

14. **J.M. Duan**, Q. Wang, and J.S. Hesthaven, Machine learning enhanced aerodynamic forces prediction based on sparse pressure sensor inputs, submitted to ***AIAA J.***, 2023. *arXiv:2305.09199*.
15. **J.M. Duan**[*] and J.S. Hesthaven, Non-intrusive data-driven reduced-order modeling for time-dependent parametrized problems, submitted to ***J. Comput. Phys.***, 2023. *arXiv:2303.02986*.

Awards & Honors

Humboldt Research Fellowship for Postdoctoral Researchers, Alexander von Humboldt Foundation — July 2023
Outstanding Graduate of Peking University, Peking University — July 2021
National Scholarship for Graduate Student, Chinese Ministry of Education — December 2020
Merit Student of Peking University, Peking University — October 2020
The First Prize in Outstanding Youth Paper Award of Beijing Society of Computational Mathematics, Beijing Society of Computational Mathematics — August 2020
BICMR Scholarship for Graduate Student, Beijing International Center for Mathematical Research (BICMR), Peking University — 2019–2020
President Scholarship for PhD Student, Peking University — 2018–2020
Founder Scholarship, Peking University — September 2019
DTZ Cushman & Wakefield Scholarship, Peking University — September 2017
Outstanding Undergraduate of Peking University, Peking University — July 2016

Conferences & Talks

CAM Seminar, Southern University of Science and Technology, Shenzhen, China *(Talk: Machine learning based non-intrusive reduced-order modeling and aerodynamic forces prediction)* — July 01, 2023
ECCOMAS YIC 2023: 7th Young Investigators Conference, University of Porto, Porto, Portugal *(Talk: Non-intrusive data-driven reduced-order modeling for time-dependent parametrized problems)* — June 19-21, 2023
Swiss Numerics Day 2023, Universität Bern, Bern, Switzerland *(Talk: Machine learning enhanced aerodynamic forces prediction based on sparse pressure sensor inputs)* — June 07, 2023
MATHICSE Retreat, Bienne, Switzerland *(Talk: Machine learning enhanced aerodynamic forces prediction based on sparse pressure sensor inputs)* — June 05-06, 2023
Oberseminar, host by Prof. Christian Klingenberg, online *(Talk: Data-driven reduced-order modeling for time-dependent parametrized problems)* — November 17, 2022
MultiMat 2022: 10th International Conference on Numerical Methods for Multi-Material Fluid Flow, Universität Zürich, Zürich, Switzerland *(Talk: High-order accurate entropy stable adaptive moving mesh methods)* — August 22-26, 2022
MATHICSE Retreat, Villars-sur-Ollon, Switzerland *(Talk: High-order accurate entropy stable adaptive moving mesh methods)* — June 27-29, 2022
Symposium on High-Fidelity Numerical Simulation of Fluid Problems, Peking University, Beijing, China *(Talk: Entropy stable schemes for RHD)* — June 05-07, 2021

Conferences & Talks (continued)

Forum of Numerical Methods and Applications in Fluids, Xiangtan University, Xiangtan, China *(Talk: Entropy stable adaptive moving mesh schemes for RHD)* — December 11-13, 2020

Student Forum of Chinese Society of Industrial and Applied Mathematics, online *(Talk: Entropy stable adaptive moving mesh schemes for RHD)* — November 14-15, 2020

The National Mechanics Graduate Student Forum, Peking University, Beijing, China *(Poster: High-order entropy stable DG schemes for RMHD)* — November 06-08, 2020

Selection of Excellent Young Scholar's paper of Beijing Society of Computational Mathematics, online *(Talk: PCP Lagrangian scheme for RHD. The first prize.)* — August 30, 2020

Annual Meeting on High Resolution Method for Multi-Material Hydrodynamics of Science Challenge Project, Xiamen University, Xiamen, China *(Talk: PCP Lagrangian scheme for RHD)* — November 29-December 01, 2019

Workshop on Numerical Methods for Complex Physical Problems, Nanjing University of Aeronautics and Astronautics, Nanjing, China *(Talk: High-order entropy stable finite difference schemes for RHD)* — August 28-30, 2019

The 12th National Annual Meeting of Computational Mathematics, Harbin, China *(Talk: High-order entropy stable finite difference schemes for RHD)* — July 31-August 04, 2019

Graduate Student Forum of Chinese Society of Industrial and Applied Mathematics, Academy of Mathematics and System Science, Chinese Academy of Science, Beijing, China *(Talk: PCP Lagrangian scheme for RHD)* — June 22, 2019

Annual Meeting of Center for Applied Physics and Technology, Peking University, Beijing, China *(Talk: PCP Lagrangian scheme for RHD)* — December 13, 2018

Annual Meeting of Science Challenge Project, Jilin University, Changchun, China *(Talk: PCP Lagrangian scheme for RHD (with Dan Ling), selected as one of the five best posters)* — November 17-19, 2018

Beijing Seminar on Computational Fluid Dynamics, Beijing Institute of Applied Physics and Computational Mathematics, Beijing, China *(Talk: PCP Lagrangian scheme for RHD)* — November 11, 2018

Teaching Assistant

Analysis III, École Polytechnique Fédérale de Lausanne — Fall 2022

Advanced Analysis I, École Polytechnique Fédérale de Lausanne — Fall 2021

Numerical Methods of Partial Differential Equations, Peking University — Fall 2019

Linear Algebra B, Peking University — Fall 2018

Advanced Algebra II, Peking University — Spring 2018

Linear Algebra B, Peking University — Fall 2017

Mathematical Modeling, Peking University — Spring 2017

Partial Differential Equations, Peking University — Fall 2016

Supervision

Master thesis: Enhancing numerical simulations of hyperbolic conservation laws using entropy stable schemes and adaptive moving mesh method. Kovacic Bartul, EPFL, with Prof. Jan S. Hesthaven — Fall, 2023

Semester project: Scalable implementation of high-order entropy stable finite difference schemes. Kovacic Bartul, EPFL, with Prof. Jan S. Hesthaven — Fall, 2022

Master thesis: High-order entropy stable discontinuous Galerkin schemes using artificial viscosity. Jaugey Louis Vincent Marie, EPFL, with Prof. Jan S. Hesthaven — Fall, 2022

Master thesis: Investigation of the aerosol evolution and delivery into the upper airway under transient conditions. Zacchei Filippo, EPFL, with Prof. Jan S. Hesthaven — Fall, 2022

Research Projects

New Efficient Structure-Preserving Numerical Methods for the Multi-dimensional Euler Equations: 2023-2025
design efficient adaptive moving mesh methods and reduced-order models with structure preservation for solving the multi-dimensional Euler equations
Supported by Alexander von Humboldt-Stiftung. Design and verification of numerical methods. PI

Sense Dynamics: construct precise surrogate models of transient nonlinear physical phenomena related to aerodynamics 2021-2022
Supported by Swiss Data Science Center. Design and verification of numerical simulations for a 3D drone. PI: Dr. Doytchinov Iordan

High-Order Accurate Adaptive Moving Mesh Methods for Compressible Fluid Flows: design and verification of high-order accurate adaptive moving mesh methods for solving the Euler and Navier-Stokes equations in 2D and 3D 2021-2022
Supported by National Numerical Windtunnel Project. Design and verification of numerical methods. PI: Prof. Huazhong Tang

Computational Methods for the Interface and Elastoplastic Fracture in Fluid Mechanics: design and verification of high-order accurate adaptive moving mesh methods for solving multi-material flows 2019-2020
Supported by Science Challenge Project. Design and verification of moving mesh schemes for multi-component flows. PI: Prof. Huazhong Tang

High-Order Accurate Robust Numerical Schemes for Multi-Material Implosion Hydrodynamics: 2016-2018
research on high-order accurate Lagrangian schemes for solving compressible hydrodynamics
Supported by Science Challenge Project. Verification of high-order accurate Lagrangian schemes. PI: Prof. Huazhong Tang

Professional Services

- Refereeing: AMS Mathematical Reviews, Journal of Computational Physics, Journal of Computational and Applied Mathematics, Communications in Nonlinear Science and Numerical Simulation, International Journal for Numerical Methods in Engineering, East Asian Journal on Applied Mathematics, Communications in Computational Physics, Journal of Scientific Computing, International Journal of Computational Methods

Other Information

- Skills: C, C++, MPI, Python, PyTorch, MATLAB, OpenFOAM, PETSc, Linux shell, Fortran, LaTeX, . . .

References

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