

Junming DUAN (段俊明)

HUMBOLDT RESEARCH FELLOW

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Academic Positions

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|---------------------------------|---|
| October 2023 – September 2025 | Humboldt Research Fellow
Institut für Mathematik, Universität Würzburg, Germany
<i>Host Professor: Prof. Dr. Christian Klingenberg</i> |
| September 2021 – September 2023 | Postdoctoral Researcher
MCSS, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland
<i>Mentor: Prof. Jan S. Hesthaven</i> |

Education

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|----------------------------|---|
| September 2016 - July 2021 | Ph.D. in Computational Mathematics
Peking University, China
<i>Entropy stable numerical methods for special relativistic (magneto)hydrodynamics</i>
<i>Advisor: Prof. Huazhong Tang</i> |
| 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
- Active flux methods
- Model order reduction
- Reduced-order modeling
- Machine-learning-enhanced data-driven methods

Research Publications

PREPRINTS

19. **J.M. Duan***, W. Barsukow, and C. Klingenberg, Active flux methods for hyperbolic conservation laws – flux vector splitting and bound-preservation, submitted to *SIAM J. Sci. Comput.*, **in revision**, 2024. *arXiv:2405.02447*.
18. J. Wang, Y. Zhou, **J.M. Duan**, Z.W. Ma, and W. Zhang, Adaptive moving mesh CLT code for stellarator MHD simulations, submitted to *Comput. Phys. Commun.*, 2024.
17. **J.M. Duan**, B. Kovacic, and J.S. Hesthaven, Multi-GPU accelerated high-order schemes for hyperbolic conservation laws on adaptive moving meshes, **in preparation**.

JOURNAL ARTICLES

16. Z.H. Zhang, H.Z. Tang, and **J.M. Duan***, High-order accurate well-balanced energy stable finite difference schemes for multi-layer shallow water equations on fixed and adaptive moving meshes, *J. Comput. Phys.*, 517: 113301, 2024. *arXiv:2311.08124*.
15. **J.M. Duan**, Q. Wang, and J.S. Hesthaven, Machine-learning-enhanced aerodynamic forces prediction based on sparse pressure sensor inputs, *AIAA J.*, 62(7): 2601-2621, 2024. *arXiv:2305.09199*.
14. **J.M. Duan*** and J.S. Hesthaven, Non-intrusive data-driven reduced-order modeling for time-dependent parametrized problems, *J. Comput. Phys.*, 497: 112621, 2024. *arXiv:2303.02986*.

13. J. Wang, **J.M. Duan**, Z.W. Ma, and W. Zhang, An adaptive moving mesh finite difference scheme for tokamak magneto-hydrodynamic simulations, **Comput. Phys. Commun.**, 294: 108951, 2024.
12. 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*.
11. 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*.
10. **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*.
9. **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*.
8. **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*.
6. **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*.
5. **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*.
4. **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*.
3. 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*.
2. **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)
1. **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*.

Major Awards & Honors

Humboldt Research Fellowship Alexander von Humboldt Foundation	July 2023
Outstanding Graduate of Peking University Peking University	July 2021
National Scholarship for Graduate Student Ministry of Education of P.R. China	December 2020
The First Prize in Outstanding Youth Paper Award Beijing Society of Computational Mathematics	August 2020
BICMR Scholarship for Graduate Student Beijing International Center for Mathematical Research	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

XVIII. Würzburg Workshop on Stellar Astrophysics Heidelberg Institute for Theoretical Studies (HITS), Heidelberg, Germany	December 09-11, 2024
<i>Talk: On limiting for the Active Flux methods for hyperbolic conservation laws</i>	
High-Order Nonlinear numerical Methods for evolutionary PDEs: theory and applications, HONOM Chania, Crete Island, Greece	September 08-13, 2024
<i>Talk: On limiting for the Active Flux methods for hyperbolic conservation laws</i>	

Conferences & Talks (continued)

Lecture Series of Modern Computational Methods Beijing Institute of Applied Physics and Computational Mathematics (online)	July 27, 2024
<i>Talk: Entropy stable schemes for hyperbolic conservation laws</i>	
Seminar Talk Southern University of Science and Technology, Shenzhen, China	March 21, 2024
<i>Talk: Bound-preserving active flux methods for one-dimensional hyperbolic conservation laws and flux vector splitting for point value update</i>	
Development of High-Order Methods for Hyperbolic PDEs Southern University of Science and Technology, Shenzhen, China	March 15-19, 2024
Simultaneously used Point values, Averages and Moments and their Inter-Relation: Active Flux, Multi-Moment Method, Virtual Finite Elements and related numerical methods Maxwell Center, Cambridge, UK	March 06-08, 2024
<i>Talk: Flux-vector splitting for point value update in active flux methods and limiting</i>	
XVII. Würzburg Workshop on Stellar Astrophysics Heidelberg Institute for Theoretical Studies (HITS), Heidelberg, Germany	December 18-19, 2023
<i>Plenary talk: Adaptive moving mesh methods in hydrodynamics</i>	
CAM Seminar Southern University of Science and Technology, Shenzhen, China	July 01, 2023
<i>Talk: Machine learning based non-intrusive reduced-order modeling and aerodynamic forces prediction</i>	
ECCOMAS YIC 2023: 7th Young Investigators Conference University of Porto, Porto, Portugal	June 19-21, 2023
<i>Talk: Non-intrusive data-driven reduced-order modeling for time-dependent parametrized problems</i>	
Swiss Numerics Day 2023 Universität Bern, Bern, Switzerland	June 07, 2023
<i>Talk: Machine learning enhanced aerodynamic forces prediction based on sparse pressure sensor inputs</i>	
Oberseminar hosted by Prof. Christian Klingenberg, online	November 17, 2022
<i>Talk: Data-driven reduced-order modeling for time-dependent parametrized problems</i>	
MultiMat 2022: 10th International Conference on Numerical Methods for Multi-Material Fluid Flow Universität Zürich, Zürich, Switzerland	August 22-26, 2022
<i>Talk: High-order accurate entropy stable adaptive moving mesh methods</i>	
Symposium on High-Fidelity Numerical Simulation of Fluid Problems Peking University, Beijing, China	June 05-07, 2021
<i>Talk: Entropy stable schemes for RHD</i>	
Forum of Numerical Methods and Applications in Fluids Xiangtan University, Xiangtan, China	December 11-13, 2020
<i>Talk: Entropy stable adaptive moving mesh schemes for RHD</i>	
Annual Meeting on High Resolution Method for Multi-Material Hydrodynamics of Science Challenge Project Xiamen University, Xiamen, China	November 29-December 01, 2019
<i>Talk: PCP Lagrangian scheme for RHD</i>	
Workshop on Numerical Methods for Complex Physical Problems Nanjing University of Aeronautics and Astronautics, Nanjing, China	August 28-30, 2019
<i>Talk: High-order entropy stable finite difference schemes for RHD</i>	
The 12th National Annual Meeting of Computational Mathematics Harbin, China	July 31-August 04, 2019
<i>Talk: High-order entropy stable finite difference schemes for RHD</i>	
Annual Meeting of Science Challenge Project Jilin University, Changchun, China	November 17-19, 2018
<i>Talk: PCP Lagrangian scheme for RHD (with Dan Ling), selected as one of the five best posters</i>	
Beijing Seminar on Computational Fluid Dynamics Beijing Institute of Applied Physics and Computational Mathematics, Beijing, China	November 11, 2018
<i>Talk: PCP Lagrangian scheme for RHD</i>	

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

Teaching Assistant (continued)

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: GPU-accelerated numerical simulations of hyperbolic conservation laws using entropy stable schemes and adaptive moving mesh method Bartul Kovacic, EPFL, with Prof. Jan S. Hesthaven	Fall, 2023
Semester project: Scalable implementation of high-order entropy stable finite difference schemes Bartul Kovacic, EPFL, with Prof. Jan S. Hesthaven	Fall, 2022
Master thesis: High-order entropy stable discontinuous Galerkin schemes using artificial viscosity Louis Vincent Marie Jaugey, EPFL, with Prof. Jan S. Hesthaven	Fall, 2022
Master thesis: Investigation of the aerosol evolution and delivery into the upper airway under transient conditions Filippo Zacchei, EPFL, with Prof. Jan S. Hesthaven	Fall, 2022

Research Grants & Projects

New Efficient Structure-Preserving Numerical Methods for the Multi-dimensional Euler Equations: design efficient adaptive moving mesh methods and reduced-order models with structure preservation for solving the multi-dimensional Euler equations PI <i>Supported by Alexander von Humboldt-Stiftung</i>	2023-2025
Sense Dynamics: construct precise surrogate models of transient nonlinear physical phenomena related to aerodynamics PI: Dr. Doytchinov Iordan <i>Supported by Swiss Data Science Center</i>	2021-2022
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 PI: Prof. Huazhong Tang <i>Supported by National Numerical Windtunnel Project</i>	2021-2022
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 PI: Prof. Huazhong Tang <i>Supported by Science Challenge Project</i>	2019-2020
High-Order Accurate Robust Numerical Schemes for Multi-Material Implosion Hydrodynamics: research on high-order accurate Lagrangian schemes for solving compressible hydrodynamics PI: Prof. Huazhong Tang <i>Supported by Science Challenge Project</i>	2016-2018

Professional Services

- Reviewer/Referee for: 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, Computational Geosciences, Numerical Methods for Partial Differential Equations

Other Information

- Programming skills: C, C++, Python, Julia, MATLAB, Fortran, MPI, PyTorch, OpenFOAM, PETSc, Linux shell, \LaTeX , . . .
- Languages: English, Chinese (native)

References

Prof. Dr. Huazhong Tang

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Prof. Dr. Jan S. Hesthaven

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