Junming DUAN (段俊明)

Humboldt Research Fellow

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Academic Positions

October 2023 – September 2025 **Humboldt Research Fellow**
Institut für Mathematik, 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
- Active flux methods
- Model order reduction
- Reduced-order modeling
- Machine-learning-enhanced data-driven methods

Research Publications

Preprints

19. 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.
18. **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

17. **J.M. Duan***, W. Barsukow, and C. Klingenberg, Active flux methods for hyperbolic conservation laws – flux vector splitting and bound-preservation, accepted by ***SIAM J. Sci. Comput.***, 2024. *arXiv:2411.00065*.
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

High-Order NOnlinear numerical Methods for evolutionary PDEs: theory and applications, HONOM | Chania, Crete Island, Greece — September 08-13, 2024
Talk: On limiting for the Active Flux methods for hyperbolic conservation laws

Lecture Series of Modern Computational Methods | Beijing Institute of Applied Physics and Computational Mathematics (online) — July 27, 2024
Talk: Entropy stable schemes for hyperbolic conservation laws

Seminar Talk | Southern University of Science and Technology, Shenzhen, China — March 21, 2024
Talk: Bound-preserving active flux methods for one-dimensional hyperbolic conservation laws and flux vector splitting for point value update

Conferences & Talks (continued)

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

Talk: Flux-vector splitting for point value update in active flux methods and limiting

XVII. Würzburg Workshop on Stellar Astrophysics | Heidelberg Institute for Theoretical Studies (HITS), Heidelberg, Germany — December 18-19, 2023

Plenary talk: Adaptive moving mesh methods in hydrodynamics

CAM Seminar | Southern University of Science and Technology, Shenzhen, China — July 01, 2023

Talk: Machine learning based non-intrusive reduced-order modeling and aerodynamic forces prediction

ECCOMAS YIC 2023: 7th Young Investigators Conference | University of Porto, Porto, Portugal — June 19-21, 2023

Talk: Non-intrusive data-driven reduced-order modeling for time-dependent parametrized problems

Swiss Numerics Day 2023 | Universität Bern, Bern, Switzerland — June 07, 2023

Talk: Machine learning enhanced aerodynamic forces prediction based on sparse pressure sensor inputs

Oberseminar | hosted by Prof. Christian Klingenberg, online — November 17, 2022

Talk: Data-driven reduced-order modeling for time-dependent parametrized problems

MultiMat 2022: 10th International Conference on Numerical Methods for Multi-Material Fluid Flow | Universität Zürich, Zürich, Switzerland — August 22-26, 2022

Talk: High-order accurate entropy stable adaptive moving mesh methods

Symposium on High-Fidelity Numerical Simulation of Fluid Problems | Peking University, Beijing, China — June 05-07, 2021

Talk: Entropy stable schemes for RHD

Forum of Numerical Methods and Applications in Fluids | Xiangtan University, Xiangtan, China — December 11-13, 2020

Talk: Entropy stable adaptive moving mesh schemes for RHD

Annual Meeting on High Resolution Method for Multi-Material Hydrodynamics of Science Challenge Project | Xiamen University, Xiamen, China — November 29-December 01, 2019

Talk: PCP Lagrangian scheme for RHD

Workshop on Numerical Methods for Complex Physical Problems | Nanjing University of Aeronautics and Astronautics, Nanjing, China — August 28-30, 2019

Talk: High-order entropy stable finite difference schemes for RHD

The 12th National Annual Meeting of Computational Mathematics | Harbin, China — July 31-August 04, 2019

Talk: High-order entropy stable finite difference schemes for RHD

Annual Meeting of Science Challenge Project | Jilin University, Changchun, China — November 17-19, 2018

Talk: PCP Lagrangian scheme for RHD (with Dan Ling), selected as one of the five best posters

Beijing Seminar on Computational Fluid Dynamics | Beijing Institute of Applied Physics and Computational Mathematics, Beijing, China — November 11, 2018

Talk: PCP Lagrangian scheme for RHD

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: 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 — 2023-2025
PI | *Supported by Alexander von Humboldt-Stiftung*

Sense Dynamics: construct precise surrogate models of transient nonlinear physical phenomena related to aerodynamics — 2021-2022
PI: Dr. Doytchinov Iordan | *Supported by Swiss Data Science Center*

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
PI: Prof. Huazhong Tang | *Supported by National Numerical Windtunnel Project*

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
PI: Prof. Huazhong Tang | *Supported by Science Challenge Project*

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

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

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References (continued)

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