Vatsalya Sharma

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Research Interest

- Hypersonic flow, plasma, turbulent flow, supersonic flow, magneto-hydrodynamics, higher order Computational Fluid Dynamics, large-scale code development for CFD, radio communication blackout, and data-driven fluid mechanics.

Research Experience

2020 – present
- **Postdoctoral Reseacher**, Center for Mathematical Plasma and Astrophysics, KU Leuven, Belgium.
  Project: *MHD Enhanced Entry System for Space Transportation*.
  Role: Develop Thermochemical Non-Equilibrium CFD solver coupled with MHD to explore the physics for novel hypersonic vehicle applications.

Education

2014 – 2020
- **Ph.D.** at Department of Mechanical and Aerospace Engineering, Indian Institute of Technology Hyderabad, India.
  Thesis: *Cold Flow Optimization of a SCRAMJET Engine Using the In-house Parallel Three-Dimensional Unstructured Grid CFD Solver*.

2012 – 2014
- **Master of Technology (M.Tech.)** in Thermo-Fluid Engineering
  Department of Mechanical and Aerospace Engineering, Indian Institute of Technology Hyderabad, India.
  Thesis: *Development of GPU parallelized 3D CFD Solver for Large Eddy Simulations*.

2007 – 2011
- **Bachelor of Technology (B.Tech.)** in Mechanical Engineering
  Department of Mechanical Engineering, College of Engineering Roorkee, India.

Awards and Achievements

2023, 2022
- Twice recipient of the **FWO Computational Grant**, which is awarded by the Belgian Govt to use the tier-1 Flemish (Belgian) HPC for 1 million core hours.

2020
- **Research Excellence Award**, at IIT Hyderabad, for best Ph.D. thesis, Mechanical and Aerospace Engineering.

2013
- **Academic Excellence Award**, at IIT Hyderabad, for securing the highest CGPA in MTech, Mechanical and Aerospace Engineering.

2012-2020
- **MHRD fellowship** awarded by Ministry of Human Resources (MHRD), Govt. of India.

2012
- **Graduate Aptitude test in Engineering** Exam cleared in 2012 with all India rank 713 of 200,000 candidates for admission into M.Tech. at the IITs in India.

2011
- Recipient of the **Kaizen Award**, awarded by SKF, India for innovation in optimizing coolant flow rate during manufacturing on the line.

Research Fundings

2023, 2024 ◇ Investigators: Vatsalya Sharma.
Location: CmPA, KU Leuven, Belgium.
Funding Agency: Research Foundation - Flanders (FWO), Belgium.
Topic: *Numerical simulation of re-entry vehicle aerothermodynamics using in-house CFD solver.*
Additional information: Grant for using tier 1 VSC HPC of Belgian Govt for 1 million core hours, awarded twice.

2019 – 2020 ◇ Investigators: Prof. Vinayak Eswaran, and Vatsalya Sharma.
Location: Department of Mechanical and Aerospace Engineering, Indian Institute of Technology Hyderabad, India.
Funding Agency: Defense Research and Development Labs, Hyderabad, India.
Topic: *Development and validation of CFD solver for aerospace applications*.

Major CFD Codes Developed

2020 – present ◇ **COMET:** Thermo-chemical non-Equilibrium (TCNEQ) coupled MHD CFD solver for Re-entry applications.
• Developed in COOLFluiD CFD platform in C++ and Python during postdoc.
• Coupled the TCNEQ Navier stokes equations with Maxwell equations for low magnetic Reynolds number.

2014 – 2020 ◇ **Jatayu**: In-house Reynolds Averaged Navier-Stokes (RANS) based turbulent, three-dimensional, unstructured grid, Computational Fluid Dynamics (CFD) solver for high-speed aerospace applications with the density-based algorithm.
• Written in C++ and parallelized using MPI with Metis for domain decomposition.
• Successfully deployed on Amazon EC2 cloud computing service, with good speedups after several validation and verification studies, including full-body aircraft simulations.

2013 – 2014 ◇ **Thunderstorm**: GPU parallelized 3D CFD Solver for Large Eddy Simulations.
• 3-D incompressible CFD unstructured grid solver for Large Eddy Simulation (LES), using Graphics Processor Units (GPU) for parallelization was developed using Nvidia CUDA and C.
• Coloring algorithm for domain decomposition.

Teaching Experience

Thesis supervision, KU Leuven

2022 ◇ **Master's Thesis supervised**: 1
Project: *Controlled Droplet-on-Demand Deposition in Plasma–MIG Process: A Numerical Simulation Study*.

Teaching Assistant, KU Leuven

2023 ◇ **Introduction to Plasma Dynamics** (15 students/year).

Senior Teaching Assistant, IIT-H

2014-2020 ◇ **Advanced Computational Fluid Dynamics** (60 students/year) .
◇ **Numerical modeling using CFD tools** (100 students/year).

Junior Teaching Assistant, IIT-H

2012-2014 ◇ Fluid Mechanics lab, heat transfer lab, and engineering drawing (60 students/course/year).

Industry Work Experience

2011 – 2012 ◇ **Assistant Manager** of Production at SKF Haridwar, India
Role: Responsible for leading a team of 15 associates in manufacturing Deep Grove Ball Bearings for different automobiles.

Active Collaborations

- ◇ **IIT Patna, India**
  Collaborator: Dr. Ashwani Assam, Asst. Prof. at Department of Mechanical Engineering.
  Area: *Using CFD and DSMC methods for rarified atmospheric entry*.
- ◇ **Von Karman Institute of Fluid Dynamics, Belgium**
  Collaborator:Dr. Alan Viladegut and Diana Luis.
  Area: *Experimental and computational investigation of radio blackout phenomena using plasma wind tunnels*.
- ◇ **University of Illinois at Urbana Champaign, USA**
  Collaborator: Prof. Marco Panesi and Dr. Alessandro Munafo, Aerospace Engineering Department.
  Area: *Computational modeling of TCNEQ source terms in PLATO software*. Research output: 1 conference proceeding.
- ◇ **KU Leuven, Belgium**
  Collaborator: Prof. Abhay Sharma and Dr. Angshuman Kapil, Institute of Welding Technology, Department of Material Engineering.
  Area: *Computational modeling of droplet in demand Plasma MIG process*.

Service to Profession

Journal Reviewer

2017 - present ◇
- **Physics of Fluids**, American Institute of Physics (AIP) Publishing.
- **International Communication in Heat and Mass Transfer**, Elsevier.
- **Combustion Science and Technology**, Taylor and Francis.
- **Aerospace Science and Technology**, Elsevier.
- **American Institute of Aeronautics and Astronautics Journal**, AIAA.

Professional Body Membership

2023 - present ◇ **American Institute of Aeronautics and Astronautics** (AIAA), young professional member.

Activities

2013-2020 ◇ **Founder and Team Principal**, IITH Racing, IIT-Hyderabad.

2014-2015 ◇ **Coordinator**, Torque, the Automobile Club, IIT Hyderabad.

2013-2014 ◇ **Placement Coordinator**, Mechanical and Aerospace Engineering Department, IIT Hyderabad.

2008-2011 ◇ Winner of several hobby robotics competitions during my undergrad in engineering.

2010-2011 ◇ **President**, The Robotics and Innovation Club, COE-Roorkee.

Relevant Coursework

Under Graduate
- Fundamental courses such as fluid dynamics, thermodynamics, heat transfer, and combustion, with relevant lab work.

Graduate
- Computational Fluid Dynamics (basic and advanced), compressible flows, scientific programming, viscous fluid flow, turbulence, advanced heat transfer, advanced thermodynamics with relevant lab courses such as CFD modeling, hypersonic flow, high-temperature gas dynamics, data-driven fluid mechanics.

Research Publications

Journal Articles

1. R. Dhib, F. B. Ameur, **V. Sharma**, A. Lani, and S. Poedts, "Toward high-order solar corona simulations: A high-order hyperbolized poisson approach for magnetic field initialization," *The Astrophysical Journal*, vol. 980, no. 2, p. 163, 2025. DOI: https://10.3847/1538-4357/adace5.
2. R. Dhib, **V. Sharma**, A. Lani, and S. Poedts, "Input/output library for higher-order computational fluid dynamics data," *SoftwareX*, vol. 28, p. 101 943, 2024. DOI: https://doi.org/10.1016/j.softx.2024.101943.
3. A. Kapil, **V. Sharma**, J. De Pauw, and A. Sharma, "Exploring impact, spreading, and bonding dynamics in molten metal deposition for novel drop-on-demand printing," *Materials Design*, vol. 238, p. 112 633, 2024. DOI: 10.1016/j.matdes.2024.112633.
4. J. Laur, V. Giangaspero, **V. Sharma**, A. Lani, and J. Thoemel, "Radio communication blackout mitigation: Analyzing magnetic field effects via ray-tracing analysis," *AIAA Journal*, vol. 62, no. 6, pp. 2024–2035, May 2024. DOI: 10.2514/1.J062660.
5. **V. Sharma**, V. Giangaspero, S. Poedts, and A. Lani, "Influence of magnetohydrodynamics configuration on aerothermodynamics during Martian entry," *Physics of Fluids*, vol. 36, 3 2024. DOI: 10.1063/5.0191101.
6. V. F. Giangaspero, **V. Sharma**, J. Laur, *et al.*, "3D ray tracing solver for communication blackout analysis in atmospheric entry missions," *Computer Physics Communications*, vol. 286, p. 108 663, 2023. DOI: 10.1016/j.cpc.2023.108663.
7. A. Kapil, N. Kayarthaya, **V. Sharma**, and A. Sharma, "Capturing droplet flight and impingement behavior in plasma–mig process for metal droplet-on-demand applications," *Journal of Materials Processing Technology*, vol. 316, p. 117 955, 2023. DOI: 10.1016/j.jmatprotec.2023.117955.
8. A. Lani, **V. Sharma**, V. F. Giangaspero, S. Poedts, A. Viladegut, and O. Chazot, "A magnetohydrodynamic enhanced entry system for space transportation: MEESST," *Journal of Space Safety Engineering*, vol. 10, no. 1, pp. 27–34, 2023. DOI: 10.1016/j.jsse.2022.11.004.
9. **V. Sharma** and A. Assam, "Aero-thermal analysis of rarefied flow over inverse cone shaped objects using direct simulation monte carlo analysis," *ASME Journal of Heat and Mass Transfer*, pp. 1–40, 2023. DOI: 10.1115/1.4062754.
10. **V. Sharma** and A. Assam, "Evaluation of novel wall function approach for supersonic flow problems involving separations induced by geometry and shocks," *Computers & Mathematics with Applications*, vol. 123, pp. 75–88, 2022. DOI: 10.1016/j.camwa.2022.08.001.
11. **V. Sharma**, V. Eswaran, and D. Chakraborty, "Influence of isolator section on the shock augmented mixing in scramjet engine," *Aerospace Science and Technology*, vol. 130, p. 107 900, 2022. DOI: 10.1016/j.ast.2022.107900.

12. **V. Sharma**, V. Eswaran, and D. Chakraborty, "Computational analysis of transverse sonic injection in supersonic crossflow using RANS models," *Journal of Fluids Engineering*, vol. 142, no. 6, p. 061 502, 2020. DOI: 10.1115/1.4045985.

13. **V. Sharma**, V. Eswaran, and D. Chakraborty, "Determination of optimal spacing between transverse jets in a SCRAMJET engine," *Aerospace Science and Technology*, vol. 96, p. 105 520, 2020. DOI: 10.1016/j.ast.2019.105520.

14. **V. Sharma**, V. Eswaran, and D. Chakraborty, "Effect of fuel-jet injection angle variation on the overall performance of a SCRAMJET engine," *Aerospace Science and Technology*, vol. 100, p. 105 786, 2020. DOI: 10.1016/j.ast.2020.105786.

15. **V. Sharma**, V. Eswaran, and D. Chakraborty, "Effect of location of a transverse sonic jet on shock augmented mixing in a SCRAMJET engine," *Aerospace Science and Technology*, vol. 96, p. 105 535, 2020. DOI: 10.1016/j.ast.2019.105535.

16. A. Assam, N. Narayan Kalkote, **V. Sharma**, and V. Eswaran, "An automatic wall treatment for Spalart–Allmaras turbulence model," *Journal of Fluids Engineering*, vol. 140, no. 6, p. 061 403, 2018. DOI: 10.1115/1.4039087.

Under Review

1. V. Giangaspero, **V. Sharma**, A. Lani, and S. Poedts, *BORAT-EM: High-frequency electromagnetic solver for blackout analysis*, Computer Physics Communications, Elsevier. Submitted.

Conference Proceedings

1. V. Giangaspero, **V. Sharma**, A. Lani, and S. Poedts, "Raytracing analysis of blackout phases during Earth re-entry," in *AIAA Aviation 2024 Forum*, Jul 29- Aug 2, 2024, Las Vegas, NV, USA., 2024. DOI: 10.2514/6.2024-4047.

2. **V. Sharma**, V. Eswaran, and D. Chakraborty, "Numerical study of maneuverability control in high-speed aero-vehicles using transverse sonic jet injectors," in *AIAA SciTech 2024*, January 8-12, 2024, Orlando, Florida, USA., 2024. DOI: 10.2514/6.2024-0699.

3. **V. Sharma**, V. Giangaspero, S. Poedts, and A. Lani, "Validation and verification of the implicit thermo-chemical non-equilibrium cfd solver in COOLFluiD with PLATO," in *AIAA SciTech 2024*, January 8-12, 2024, Orlando, Florida, USA., 2024. DOI: 10.2514/6.2024-2728.

4. A. Kapil, **V. Sharma**, J. De Pauw, and A. Sharma, "A novel molten metal deposition-based additive manufacturing technique for aluminum alloys," in *Proceedings of the 76th IIW Annual Assembly and Intl. Conf. on Welding and Joining*, July 16-21, 2023, Singapore., 2023.

5. J. Giacomelli, H. G., **V. Sharma**, A. Lani, N. Donaldson, and M. Kim, "Numerical rebuilding of magnetic heat flux control experiments for re-entry vehicles by enhanced mhd simulation tools," in *2nd International Conference on Flight Vehicles, Aerothermodynamics and Re-entry Missions Engineering (FAR)*, Heilbronn, Germany, 2022.

6. V. Giangaspero, **V. Sharma**, A. Lani, and S. Poedts, "Development of three-dimensional ray tracing solver for communication blackout in atmospheric entries," in *Proceedings of International Conference on Computational Fluid Dynamics (ICCFD) 2022*, Hawaii, USA, 2022.

7. A. Kapil, N. Kayarthaya, **V. Sharma**, and A. Sharma, "Controlled droplet-on-demand deposition in plasma–mig process: A numerical simulation study," in *International Conference on Welding and Joining*, Kyoto Japan, 2022.

8. J. Laur, V. Giangaspero, **V. Sharma**, *et al.*, "The effect of an applied magnetic field onto re-entry radio communication blackout," in *2nd International Conference on Flight Vehicles, Aerothermodynamics and Re-entry Missions Engineering (FAR)*, Heilbronn, Germany, 2022.

9. **V. Sharma**, V. Eswaran, and D. Chakraborty, "Development and validation of jatayu–an in-house cfd solver for high-speed aerospace applications," in *AIAA Aviation 2022 Forum*, 2022, p. 3224. DOI: 10.2514/6.2022-3224.

10. **V. Sharma**, J. Giacomelli, N. Donaldson, A. Lani, M. Kim, and H. George, "Assessment of CFD capabilities of various in-house solvers for modeling argon plasma MHD experiments," in *9th International Workshop on Radiation of High Temperature for Space Missions*, September 12-16, 2022, Azores, Portugal., 2022.

11. **V. Sharma**, J. Giacomelli, N. Donaldson, A. Lani, M. Kim, and H. George, "Numerical modelling verification for re-entry vehicles using enhanced MHD simulation tools," in *International Astronautical Congress 2022*, Paris, France, 2022.

12. **V. Sharma**, A. Ashwani, and V. Eswaran, "Investigation of turbulent mixing layer with compressibility corrections for RANS models," in *Proceedings of International Conference on Computational Fluid Dynamics (ICCFD)*, Barcelona, Spain, 2018.

13. **V. Sharma**, D. Chakraborty, and V. Eswaran, "Computational study of sonic injection in supersonic crossflow," in *Proceedings of the 7th International and 45th National Conference on Fluid Mechanics and Fluid Power (FMFP)*, IIT Bombay, Mumbai, India, 2018.

14. A. S. S. Chandra, **V. Sharma**, A. Assam, and V. Eswaran, "Performance of convective schemes in density-based solver," in *Proceedings of the 24th National and 2nd International ISHMT-ASTFE Heat and Mass Transfer Conference (IHMTC-2017)*, doi: Hyderabad, India, 2017, –. DOI: 10.1615/IHMTC-2017.10.

15. **V. Sharma**, A. Assam, and V. Eswaran, "Numerical simulation of turbulent high-speed plane jets- a validation with experimental results," in *Proceedings of the 24th National and 2nd International ISHMT-ASTFE Heat and Mass Transfer Conference (IHMTC-2017)*, doi: Hyderabad, India, 2017, –. DOI: 10.1615/IHMTC-2017.1220.

16. **V. Sharma**, A. Assam, and V. Eswaran, "Development of all speed three-dimensional computational fluid dynamics solver for unstructured grids"," in *Proceedings of the 6th International and 43rd National Conference on Fluid Mechanics and Fluid Power*, MNNIT, Allahabad, U.P., India, 2016.

17. K. Ravitej, **V. Sharma**, N. Sivadasan, and R. Banerjee, "Parallel AMG solver for three-dimensional unstructured grids using GPU"," in *2014 21st International Conference on High-Performance Computing (HiPC*, IEEE, 2014, pp. 1–10.

18. **V. Sharma** and R. Banerjee, "GPU parallelization of 3D CFD solver for application in LES," in *IUTAM Symposium on Advances in Computation, Modeling and Control of Transitional and Turbulent Flows*, Goa, India, 2014.

References

Prof Vinayak Eswaran (thesis advisor)
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Prof Debasis Chakraborty (thesis co-advisor)
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Mechanical Engineering Department,
Mahindra University, Hyderabad, Telangana, India.
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