HARSHIT TIWARI

FARE Fellow, Department of Physics, IIT Kanpur

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RESEARCH INTERESTS

Turbulent convection, atmospheric and astrophysical flows, compressible flows, High-Performance Computing (HPC), quantum turbulence, turbulence and nonlinear dynamics, etc

EDUCATION

Indian Institute of Technology Kanpur — Kanpur, India
Doctor of Philosophy in Physics — *August 2021 - February 2026*
- Courses on Tapestry of Field Theory, Physics of Turbulence, High-Performance Computing and Advanced Statistical Physics.
- Current Cumulative Performance Index: 9.56/10

Indian Institute of Technology Kanpur — Kanpur, India
Master of Science in Physics — *July 2019 - July 2021*
- Courses on High Energy Astrophysics, Nuclear and Particle Physics and Quantum Field Theory.
- Cumulative Performance Index: 8.30/10

Kumaun University — Nainital, India
Bachelor of Science — *July 2016 - June 2019*
- Subjects: Physics, Mathematics, Chemistry
- Percentage: 66.4%, First Class

RESEARCH EXPERIENCE

Fellowship for Academic and Research Excellence (FARE) Fellow — *March 2026 - Present*
Department of Physics, Indian Institute of Technology Kanpur
- High-resolution simulations of moist turbulent convection in Earth's troposphere.
- Thermalisation in quantum and classical Euler turbulence.
- Transients in thermal convection and energy distribution among vaious scales.

Graduate Researcher, Department of Physics, IIT Kanpur — *August 2021 - February 2026*
Supervisor: Prof. Mahendra Verma, Department of Physics, IIT Kanpur
Co-supervisor: Prof. Rajesh Ranjan, Department of Aerospace Engineering, IIT Kanpur

Thesis Title: *Compressible turbulent convection at extreme Rayleigh numbers*
- Simulated turbulent compressible convection at extreme Rayleigh numbers, revealing classical heat transport scaling laws.
- Developed a scalable Python PDE solver with GPU and MPI support for high-performance simulations.
- Applied advanced numerical methods to study shocks, turbulence, and compressible flows in astrophysics and atmosphere.

Master's Student, Department of Physics, IIT Kanpur *August 2020 - May 2021*

Supervisor: Prof. Pankaj Jain, Department of Physics, IIT Kanpur
Co-supervisor: Prof. J.S. Yadav, Department of Physics, IIT Kanpur

Project: ***Theoretical Modelling of Accretion Disk Oscillations***

- Studied acoustic normal modes in thin accretion disks using an effective Kerr potential.
- Derived a dispersion relation valid over a range of black hole spin parameters.

PUBLICATIONS

1. **H. Tiwari**, L. Sharma, and M. K. Verma, On the absence of the ultimate regime in turbulent thermal convection, *The Proceedings of the National Academy of Sciences.* 122 (44) e2513474122 (2025).
2. **H. Tiwari**, L. Sharma, and M. K. Verma, Compressible turbulent convection at very high Rayleigh numbers, *International Journal of Heat and Mass Transfer*. 242, 126821 (2025).
3. D. Singh, **H. Tiwari**, L. Sharma, and M. K. Verma, Mathematical formulation of mode-to-mode energy transfers and energy fluxes in compressible turbulence, *Physical Review Fluids.* 10, 114609 (2025).
4. L. Sharma, M. Pathak, **H. Tiwari**, and M. K. Verma, Effect of Prandtl number on turbulent compressible convection, *Physical Review Fluids.* 10, 114611 (2025).
5. L. Sharma, M. Pathak, **H. Tiwari**, and M. K. Verma, Variation of convective heat flux imbalance with Prandtl number, *Center for Turbulence Research Annual Reports Briefs* 2025.
6. D. Singh, **H. Tiwari**, L. Sharma, and M. K. Verma, Scale-by-Scale Energy Transfers and Fluxes in Compressible Turbulence, *Europhysics Letters* (2025). (Accepted)
7. **H. Tiwari**, D. Singh, M. K. Verma, and R. Ranjan, Scaling in supersonic turbulence: Energy spectra and fluxes using high-fidelity direct numerical simulations, *Physical Review E*. (Under review)
8. A. Pandey, **H. Tiwari**, K. R. Sreenivasan, Thermal convection in 1, 2, 3 and 4 dimensions, *Journal of Fluid Mechanics.* (Under review)
9. M. Pathak, L. Sharma, **H. Tiwari**, S. Aseeri, D. Keyes, and M. K. Verma, Prandtl-number dependence of positive and negative heat fluxes in turbulent compressible convection, *Phys. Rev. Fluids.* (Under review)
10. **H. Tiwari**, N. Kumar, M. K. Verma, and S. Ravichandran, Direct numerical simulations of moist turbulent compressible convection. (Under preparation)
11. **H. Tiwari**, A. Pandey, K. R. Sreenivasan, Scaling laws in four-dimensional turbulent convection. (Under preparation)
12. D. Singh, **H. Tiwari**, and M. K. Verma, Thermalization in compressible Euler and quantum turbulence. (Under preparation)
13. N. Kumar, **H. Tiwari**, M. K. Verma, and S. Ravichandran, Intermittency in conditionally unstable moist convection. (Under preparation)

CONFERENCES AND WORKSHOPS

- Participated in the workshop “Instabilities and transitions in geophysical flows” at the **Mathematical Developments in Geophysical Fluid Dynamics** trimester program at *Institute Henri Poincaré, Paris, France.*
- Talk on “High-resolution simulations of dry and moist turbulent convection” at **ICTS Program on Moist Convective Dynamics of Monsoon II 2026.**
- Participated in the **Indo-Japanese Workshop for CFD-based AI and HPC 2025** at **IIT Kanpur.**
- Talk on “Compressible turbulent convection at very high Rayleigh numbers” at the **APS Division of Fluid Dynamics Annual Meeting 2025** in *Houston, Texas, USA.*
- Poster presentation titled “Compressible turbulent convection at extreme Rayleigh numbers” at **The Variable Sun: Past, Present, and Future Perspectives 2025** at *Thiruvananthapuram, India.*

- Talk on "Classical 1/3 Nusselt Scaling in Compressible Convection" at the **1st European Fluid Dynamics Conference (EFDC1) 2024** *at Aachen, Germany.*
- Talk on "Classical 1/3 Nusselt Scaling in Compressible Convection at Extreme Ra" at **ICTS Program on Theoretical and Practical Perspectives in Geophysical Fluid Dynamics 2024.**
- Poster presentation titled "Classical Nusselt 1/3 scaling up to Ra = 10^{16} in turbulent compressible convection" at **HPC Symposium 2024***, IIT Kanpur.*
- Oral presentation on compressible turbulent convection at the **Research Scholar Day 2024,** organised by the *Department of Physics, IIT Kanpur.*
- Participated in **Frontier Hackathon, March 2024**. We scaled the compressible finite-difference solver *Dhara* on Frontier up to 8192 AMD MI250X GPUs.
- Attended the **ICTS Program on Field Theory and Turbulence 2023**.
- Attended the **ICTS Program on Turbulence: Problems at the interface of Mathematics and Physics 2023.**
- Participated in **NSM GPU Hackathon 2022**. We ported the Quantum Solver (Gross–Pitaevskii equation) sequential code to run on multiple GPUs and scaled it on 64 Nvidia A100 GPUs.
- Attended the **ICTS Summer School on Gravitational-Wave Astronomy 2021**.

TEACHING EXPERIENCE

I have assisted in the following courses at the Indian Institute of Technology Kanpur:

- **PHY441A: Electronics** from August 2021 to May 2022.
- **PHY473A: Computational Physics** from August 2022 to November 2022.
- **PHY113A: Classical Electrodynamics** from March 2023 to November 2023.
- **NPTEL: Scientific Computing using Python** from June 2023 to November 2023.
- **NPTEL: Tapestry of Field Theory: Classical Quantum, Equilibrium, Nonequilibrium Perspectives** from January 2024 to January 2025.
- **PHY461A/462A: Experimental Physics I/II** from January 2024 to May 2025.
- **PHY111A: Undergraduate Lab** from August 2025 to August 2026.

COMPUTATIONAL SKILLS

- Advanced: **Python, parallel programming, Numba, Paraview**
- Intermediate: **Matlab, Mathematica, CUDA**
- Basic: **C++, Julia, Fortran, R**

GRANTS AND AWARDS

- Session chair for "Convection and Buoyancy-Driven Flows: Heat Transfer, Instabilities & Turbulence" at **APS Division of Fluid Dynamics Annual Meeting 2025** in *Houston, Texas, USA.*
- Recipient of the **2025 Division of Fluid Dynamics Enabling Award,** American Physical Society, supporting attendance at the 2025 DFD Annual Meeting, Nov 2025.
- Secured an All India Rank 74 among 15,000 applicants in the **IIT Joint Admission Test (JAM) 2019**, for admission to the M.Sc. program at the Indian Institute of Technology Kanpur.
- Recipient of **Merit cum Means Scholarship** at Indian Institute of Technology Kanpur, Aug 2019 - May 2021.
- Secured All India Rank 307 in **Joint Entrance Screening Test (JEST) 2019**.
- Qualified **National Defence Academy (NDA)** entrance exam in 2016.

OTHER EXPERIENCES

1. Coordinator, Adventure Sports Club, IIT Kanpur (2024–25)

- Led club activities, organizing fitness programs, treks, runs, and yoga, boosting participation and visibility.

2. Secretary, Adventure Sports Club, IIT Kanpur (2022–23, 2023–24)

- Assisted in organising events and managing logistics for outdoor activities and training sessions.

3. Election Officer, Hall 7, HEC Elections 2022

- Managed smooth conduct of hostel elections with a voter turnout of ~85%.

REFERENCES

1. **Prof. Mahendra K. Verma**
   Department of Physics, IIT Kanpur, India.
   mkv@iitk.ac.in

2. **Prof. Rajesh Ranjan**
   Department of Aerospace Engineering, IIT Kanpur, India
   rajeshr@iitk.ac.in

3. **Prof. Katepalli R. Sreenivasan**
   Professor of Physics, Mathematical Sciences, and Engineering, New York University, USA.
   katepalli.sreenivasan@nyu.edu