HARSHIT TIWARI

PhD Scholar, Department of Physics, IIT Kanpur

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RESEARCH INTERESTS

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

EDUCATION

Indian Institute of Technology Kanpur — Kanpur, India
Doctor of Philosophy in Physics — *August 2021 - October 2025 (expected)*
- 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

Graduate Researcher, Department of Physics, IIT Kanpur — *2021 - Present*

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 — *2020 - 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, Compressible turbulent convection at very high Rayleigh numbers, *International Journal of Heat and Mass Transfer*. 242, 126821 (2025). DOI: https://doi.org/10.1016/j.ijheatmasstransfer.2025.126821
2. **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* (2025). (Under Review)
3. **H. Tiwari** and M. K. Verma, Classical 1/3 Nusselt number scaling in highly turbulent compressible convection, *arxiv:2502.02611* (2025). DOI: https://doi.org/10.48550/arXiv.2502.02611
4. D. Singh, **H. Tiwari**, L. Sharma, and M. K. Verma, Scale-by-Scale Energy Transfers and Fluxes in Compressible Turbulence, *Physical Review Letters* (2025). (Under Review)
5. D. Singh, **H. Tiwari**, L. Sharma, and M. K. Verma, Multiscale energy transfers in compressible turbulence, *Physical Review Fluids* (2025). (Under Review)
6. L. Sharma, M. Pathak, **H. Tiwari**, and M. K. Verma, Effect of Prandtl number on turbulent compressible convection, *Physical Review Fluids* (2025). (Under Review)
7. **H. Tiwari**, D. Singh, M. K. Verma, and R. Ranjan, Direct numerical simulation of supersonic turbulence using a GPU-accelerated high-order solver. (Under preparation)

CONFERENCES AND WORKSHOPS

- Talk on "Classical 1/3 Nusselt Scaling in Compressible Convection" at **1st European Fluid Dynamics Conference (EFDC1)** *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.**
- 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** 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 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 Present.

SKILLS AND EXPERTISE

- Languages: Hindi (First language), English.
- Programming languages: Python and C.
- Software: MATLAB, MATHEMATICA, PARAVIEW, PHOTOSHOP and ILLUSTRATOR.
- Open source solvers: TARANG, DEDALUS.
- Expertise: Direct numerical simulations (DNS), High-performance computing, GPU programming in Python, Turbulent convection.

GRANTS AND AWARDS

- Secured an **All India Rank 74** among 15,000 applicants in **IIT Joint Admission Test (JAM) 2019**, for the admission to M.Sc. program at 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. Shashwat Bhattacharya**, School of Mechanical and Materials Engineering, IIT Mandi, India
   shashwat@iitmandi.ac.in shashwat.mnit@gmail.com