Shailendra K. Rathor

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PROFESSIONAL PROFILE

Computational physicist with 9+ years of large-scale simulation on HPC clusters including 4 years of machine learning: CUDA-accelerated Reservoir Computing, MPI-parallel turbulence DNS, and time-series prediction, underpinning first-author publications. Now focused on making ML systems fast and reliable.

PROFESSIONAL EXPERIENCE

Further Software & Research Projects Feb. 2026 – Present
Web Homepage, Germany

- Predictive maintenance: end-to-end development of a fast and accurate reservoir computing (ESN) model for remaining-useful-life prediction; independently designed, coded, tested, packaged, and documented to production-code standards.

Postdoctoral Researcher Jan. 2023 – Jan. 2026
Institute of Thermodynamics and Fluid Mechanics, TU Ilmenau, Germany

- Led the execution of a full work package on Reservoir Computing (RC) within the ERC-funded *Mesocomp* project.
- GPU-batched execution for computing Information Processing Capacity (IPC) of a Reservoir Computer using CuPy.
- Collaborated on the projects: Quantum RC using photonic Gaussian Boson Sampling and Physical RC via memristor-based on-chip architectures.

PhD Researcher Jul. 2012 – Dec. 2022
Indian Institute of Technology Kanpur, India

PhD spanning three research domains: Rotating Turbulence in Fluids, Astrophysics, and Quantum Optics

Rotating Turbulence *(PhD Thesis)*

- Built and optimized shell models and direct numerical simulations of rotating turbulent flows, parallelized with MPI and OpenMP on HPC clusters.
- Linked the dynamics at inertial and dissipation scales in these chaotic flows.

Astrophysics *(Theoretical Modelling)*

- Established a framework for magnetohydrodynamic instabilities in the intracluster medium, identifying the conditions for oscillatory marginal stability.

Quantum Optics & Optomechanics *(Theory & Simulation)*

- Modeled squeezed states of light for noise reduction, and simulated optical tweezers and optomechanical coupling for micro-particle manipulation.

EDUCATION

- **Ph.D. in Physics** Dec. 2022
  Indian Institute of Technology Kanpur, India
  Dissertation: Spatial and Temporal Statistics of Rotating Turbulence: A Dynamical System Approach

- **M.Sc. in Physics** Jun. 2012
  Indian Institute of Technology Kanpur, India
- **B.Sc. Physics and Mathematics** Nov. 2009
  MJP Rohilkhand University, Bareilly, India

KEY SCIENTIFIC & TECHNICAL SKILLS

- **Modeling & Simulation:** Computational Physics, Fluid Dynamics, Turbulence, MHD, Nonlinear Dynamical Systems, Reservoir Computing (ESN), Time-Series Prediction, Surrogate Modeling
- **Software Development:** Python, C++, Fortran, Shell Scripting (Bash) — optimized, documented, reproducible code for research and publications
- **HPC & Parallel Computing** GPU (CUDA) Kernel Optimization, MPI, OpenMP, SLURM/LSF
- **Data & I/O:** HDF5, NetCDF, Binary Serialization, High-throughput pipelines, Statistical Analysis, Matplotlib, Seaborn
- **AI & Advanced Methods:** Neural Networks, Quantum Machine Learning & Quantum Reservoir Computing (incl. photonic Gaussian Boson Sampling (GBS))
- **Environment & Tools** Linux (RHEL/Debian), Version Control (Git), JupyterLab

SELECTED PUBLICATIONS

1. **Shailendra K. Rathor**, Lina Jaurigue, Martin Ziegler, and Jörg Schumacher, "Prediction performance of random reservoirs with different topology for nonlinear dynamical systems with different number of degrees of freedom," Chaos 36, 033117 (2026).
2. **Shailendra K. Rathor**, Sagar Chakraborty, and Samriddhi Sankar Ray, "Dynamic scaling in rotating turbulence: A shell model study," Physical Review E (Letters) **105**, L063102 (2022).
3. **Shailendra K. Rathor**, Manohar K. Sharma, Samriddhi S. Ray, and Sagar Chakraborty, "Bridging inertial and dissipation range statistics in rotating turbulence," Physics of Fluids **32**, 095104 (2020).
   Note: *For a complete, real-time list of all peer-reviewed publications and conference proceedings, please visit my verified ORCID profile: orcid.org/0000-0002-2856-4751.*

CODES DEVELOPED

Linked entries are publicly available at github.com/shail-kumar.

1. Reservoir computing for predictive maintenance (in Python; Echo State Network and NG-RC, packaged and tested)
2. Helical shell model of turbulence (in C++, parallelized with MPI)
3. Multifractal analysis (package *multifracturb* and module *mfawl*, in Python)
4. Stochastic resonance (in Python, parallelized with mpi4py)
5. Synthetic turbulence (in C++ with MPI)
6. Information processing capacity of a reservoir computer (in Python, with GPU-batched execution)
7. A DNS solver for the predictability of turbulence, implemented in the code *Tarang* (C++, MPI)

LANGUAGES

English: Fluent | **German**: Basic to conversational (A2–B1, actively learning)