Pranaya Pratik Das, Ph.D.

Theoretical Physicist, India
Quantum Chaos | Nonlinear Dynamics

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Professional Summary

Theoretical physicist specialising in quantum chaos, nonlinear dynamics, and quantum information, with expertise in out-of-time-order correlators (OTOCs), spectral complexity, scrambling diagnostics, quantum scars, Lyapunov exponent analysis, and many-body dynamics. Experienced in analytical modelling, numerical simulation, Mathematica-based scientific computing, and cloud-based computational workflows. Research background spans black hole physics, active matter, statistical mechanics, nonlinear dynamical systems, and computational physics.

Technical Skills

`Programming Languages`**: Wolfram Mathematica, Fortran, MATLAB, Python**
`Cloud Workflows:` **Google Cloud Compute Engine VMs, Linux-based VM setup, SSH key authentication, PuTTY,**
`Numerical Methods:` **Multi-kernel parallelisation, matrix diagonalisation, numerical modelling, high-precision computation, data visualisation**
`Web, Documentation, and Version Control`**: HTML, CSS, Astro, GitHub, GitHub Pages, LaTeX**

Research Interests

Classical and quantum chaos; nonlinear dynamics; information scrambling; OTOC diagnostics; quantum scars; spectral statistics; Lyapunov exponent analysis; black hole thermodynamics; active matter; computational physics

Education

Ph.D. in Theoretical Physics: Quantum Chaos — EQF: Level 8
National Institute of Technology Rourkela — *July 2019 – Dec 2025*
Thesis Title: Diagnosis of Quantum Chaos in Perturbed Quantum Wells and Billiards — *Rourkela, Odisha, India*
Supervisor: Prof. Biplab Ganguli

Master of Science: Physics — EQF: Level 7
College of Basic Science and Humanities, OUAT — *Aug 2014 – Aug 2016*
Project Title: Dark Matter Signatures in Cosmic γ-Rays — *Bhubaneswar, Odisha, India*
Supervisor: Prof. Manorama Panigrahy

Bachelor of Science: Physics — EQF: Level 6
BJB Autonomous College, Utkal University — *July 2010 – May 2013*
`Project Title:` Black Hole and Its Mysteries — *Bhubaneswar, Odisha, India*

Teaching Experience

Teaching Assistance: B.Tech Physics Lab (Course Code: PH1070) — *NIT Rourkela, 2021–2023*
- `Instructor(s):` Prof. Pitanmber Mahanandia, Prof. Susanta Kumar Bisoi, Prof. Indrani Banarjee, Prof. Biplab Ganguli

Teaching Assistance: U.G. Thermal Physics Lab (Course Code: PH3074) — *NIT Rourkela, 2022–2023*
- `Instructor(s):` Prof. Biplab Ganguli

Teaching Assistant to Prof. Biplab Ganguli — *NIT Rourkela, 2021–2025*
- `Course(s):` Nonlinear Dynamics, Chaos, and Its Recent Applications (PH6114); Advanced Statistical Mechanics (PH6112); Introduction to Classical Mechanics; Electrodynamics (PH4002)

M.Sc. Research Projects — *NIT Rourkela, 2021–2024*
- Vipul Sharma | `Roll No.:` 420PH2095 | `Thesis Title:` Two & three scroll chaotic attractors | 2022
- Ayush Sahu | `Roll No.:` 418PH5033 | `Thesis Title:` Nonlinear systems and chaos | 2023
- Karishma Kujur | `Roll No.:` 421PH2125 | `Thesis Title:` Quantum chaos | 2023
- Zubair Ahmad Kumar | `Roll No.:` 422PH2069 | `Thesis Title:` Diagnosing quantum chaos using OTOC | 2024
- Vivek Sheoran | `Roll No.:` 422PH2082 | `Thesis Title:` Signature of chaos in quantum mechanics | 2024

Research Experience

• Deployed and managed Mathematica-based numerical simulations on Google Cloud Compute Engine VMs with 32 vCPUs, 128 GB RAM, and persistent disk storage, using Linux VM setup, SSH key-based authentication, and PuTTY/PuTTYgen access to perform Lyapunov exponent analysis, eigenvalue computations, and OTOC-based chaos diagnostics in quantum chaos and nonlinear dynamics research.

• Improved simulation throughput by parallelising Wolfram Language routines across multiple kernels, reducing computation time for large parameter scans and spectral calculations.

• Optimised cloud-based computational workflows by balancing VM performance, storage requirements, and cost efficiency for extended simulation runs.

• `Computational Research`: Numerical simulations, Lyapunov Exponent calculation, Poincaré Section, eigenvalue computations, spectral statistics, OTOC analysis, scrambling diagnostics, quantum chaos, nonlinear dynamics, data visualisation, reproducible computation

Publications

(1) **Morphology-resolved scrambling in a chaotic quantum billiard** — June 2026
arXiv preprint — *Under Review*
Author(s): ***Pranaya Pratik Das***
DOI: https://doi.org/10.48550/arXiv.2606.16865 — *ISSN: 2331-8422*

(2) **Chaos in cymatics-inspired Gaussian landscapes** — June 2026
arXiv preprint — *Under Review*
Author(s): Tanmayee Patra, ***Pranaya Pratik Das****, Biplab Ganguli*
DOI: https://doi.org/10.48550/arXiv.2606.09442 — *ISSN: 2331-8422*

(3) **Classical and quantum chaos in bean- and peanut-shaped billiards** — May 2026
arXiv preprint — *Under Review*
Author(s): ***Pranaya Pratik Das****, Tanmayee Patra, Biplab Ganguli*
DOI: https://doi.org/10.48550/arXiv.2501.08839 — *ISSN: 2331-8422*

(4) **Cyclically symmetric Thomas oscillators as swarmalators: A model for active fluids and pattern formation** — Aug 2025
Journal: Communications in Nonlinear Science and Numerical Simulation, Elsevier (Q1) — *pp. 109216*
Author(s): Vinesh Vijayan, ***Pranaya Pratik Das****, K Hariprasad, P Sathish Kumar* — *Impact factor: 3.8*
DOI: https://doi.org/10.1016/j.cnsns.2025.109216 — *ISSN: 10075704*

(5) **Out-of-Time-Order Correlation in perturbed quantum wells** — June 2025
Journal: European Physical Journal D, Springer Science (Q3) — *Vol. 79 no. 6 pp. 74*
Author(s): ***Pranaya Pratik Das****, Biplab Ganguli* — *Impact factor: 1.5*
DOI: https://doi.org/10.1140/epjd/s10053-025-01025-7 — *ISSN: 14346060, 14346079*

(6) **Interplay between the Lyapunov exponents and phase transitions of charged AdS black holes** — July 2024
Journal: Physical Review D, American Physical Society (Q1) — *vol. 110 no. 2 pp. 024068*
Author(s): Bhaskar Shukla, ***Pranaya Pratik Das****, David Dudal, Subhash Mahapatra* — *Impact factor: 5.3*
DOI: https://doi.org/10.1103/PhysRevD.110.024068 — *ISSN: 24700010, 24700029*

(7) **Dynamics of a charged Thomas oscillator in an external magnetic field** — Oct 2022
Journal: Physica Scripta, IOP Science (Q2) — *Vol. 97, no. 11*
Author(s): Vinesh Vijayan, ***Pranaya Pratik Das*** — *Impact factor: 2.6*
DOI: 10.1088/1402-4896/ac99ab — *ISSN: 00318949, 14024896*

Conferences, Workshops and Schools

(1) **60 Years of DFT: Advancements in Theory & Computation** — *2024*
Poster Presentation — *IIT Mandi, India*

(2) **HPC Symposium** — *2024*
Poster Presentation — *NIT Rourkela, India*

(3) **Secrets of getting published in high impact factor journals** — *2023*
Attended online — *Wiley*

(4) **Integrability, Deformations and Chaos** — *2023*
Attended online — *OIST, Onna, Okinawa, Japan*

(5) **School on Quantum Chaos** *2023*
Attended online *ICTP-SAIFR, São Paulo, Brazil*

(6) **Complex Lagrangian Problems of Particles in Flows** *2022*
Attended online *ICTS-TIFT, India*

(7) **Spring College in the Physics of Complex Systems** *2022*
Attended online *ICTP, Trieste, Italy*

Awards, Scholarships, and Achievements

`Qualified:` **National Graduate Physics Examination (NGPE) conducted by IAPT** *2012*
`Scholarships:` **P.G. Meritorious Scholarship by Institute of Mathematics and Applications (IMA)** *2014–2016*
`Scholarships:` **Medhabruti Scholarship by Odisha State Government** *2014-2016*
`Qualified:` **TIFR GS-2016 in Physics** *2016*
`Qualified:` **GATE in Physics with 94.7901 Percentile** *2019*

Language Skills

Mother Tongue: Odia
Other Languages:

English: *Listening: C2, Spoken production: C2, Reading: C2, Spoken interaction: C1, Writing: C2*
Hindi *Listening: C2, Spoken production: C2, Reading: B2, Spoken interaction: C2, Writing: B2*
Sanskrit *Listening: B2, Spoken production: A1, Reading: B2, Spoken interaction: A1, Writing: B1*
Levels: *A1 & A2: Basic user; B1 & B2: Independent user; C1 & C2: Proficient user*

Online Profiles

`Personal Homepage:` **https://ppdws.github.io/pranayapratikdas/**
`Scopus ID:` **57451177800**
`Google Scholar:` **Pranaya Pratik Das**
`LinkedIn:` **pranaya-pratik-das-28a94439b**
`arXiv:` **das_p_3**
`ORCiD ID:` **0000-0002-6025-7719**
`ResearchGate:` **Pranaya-Das**
`Instagram:` **pranaya.pratik.das**

References

Prof. Biplab Ganguli Professor
Department of Physics and Astronomy *NIT Rourkela*
Email: biplabg@nitrkl.ac.in or biplab62g@gmail.com
Relationship: PhD supervisor

Prof. Subhash Chandra Mahapatra Associate Professor
Department of Physics and Astronomy *NIT Rourkela*
Email: mahapatrasub@nitrkl.ac.in or subhashmahapatra@gmail.com
Relationship: Research collaborator and course instructor

Prof. Mithun Biswas Assistant Professor
Department of Physics and Astronomy *NIT Rourkela*
Email: biswasm@nitrkl.ac.in
Relationship: PhD DSC member and course instructor

Prof. Chhatrapati Parida Professor
Department of Physics *College of Basic Science and Humanities, OUAT*

Email: cparida@ouat.ac.in
Relationship: Course instructor