# Vaibhav **Shukla**

**Astrophysics MSc | High-Energy Astrophysics & Astroparticle Physics**

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## Education

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| Oct. 2021 – Feb. 2025 | Master of Science (MSc) in Physics, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany<br>*Specialization*: Astrophysics and Astroparticle Physics \| *Final Grade*: German 1.44 ≈ 92% \| "sehr gut" |
| Jul. 2017 – Nov. 2020 | Bachelor of Science (BSc) in Physics, Savitribai Phule Pune University (SPPU), Modern College, Pune, India<br>*Minors*: Mathematics and Statistics \| *Principal Total*: 83.83% ≈ German 1.80 \| "First Class with Distinction" |
| 2015 – 2017 | Senior Secondary (XI–XII), Central Hindu Boys School, Varanasi, India<br>CBSE All India Senior School Certificate Examination (2017) \| *Total*: 82.60% |
| 2003 – 2015 | Schooling (KG–X), New Angels Senior Secondary School, Pratapgarh, India<br>CBSE Secondary School Examination (2015) \| *CGPA*: 9.2/10 |

## Experience

**Oct. 2024 – Apr. 2023** — **Lab Tutor & Research Assistant, Dr. Karl Remeis-Sternwarte, Bamberg, Germany**

- Assisted multiwavelength astronomy research on supernova remnants (SNRs) under Prof. Dr. Manami Sasaki: analyzed archival and proprietary data on SNR candidates in the Large Magellanic Cloud (LMC), tested 1D theoretical SNR evolutionary models against observations using SNRpy simulations, consolidated the current complete sample of LMC SNRs, and performed a population study on MC-SNRs
- Supervised BSc Physics students in an experiment on charge-coupled devices (CCDs) for their astronomical internships, covering optical-CCD characteristics and post-analysis imaging of astronomical objects
- Participated in and helped run conferences, talks, and science-outreach programs; managed social media

Python | Bash | XMM-SAS | XSPEC | PyXspec | SNRpy | Astrophysical Data Analysis

**Mar. 2020 – Sep. 2019** — **Research & Development Intern, Modern Communication Technology (MCom), Pune, India**

- Worked on the design and improvement of electronic IoT and remote-sensing devices for industrial applications
- Collaborated on a remote, automated water-management system integrating sensors, motor starters, and monitoring dashboards; researched piezoelectric technology for groundwater-level pressure sensors
- Assisted in product documentation and drafting technical sections of government tender proposals

IoT | Remote Sensing | Embedded Systems | Industrial Automation | Technical Documentation

## Selected Projects

**X-ray Evolution of Supernova Remnants in the Large Magellanic Cloud (MSc Thesis)** — Sep. 2023 – Nov. 2024

Thesis PDF

Reviewed the astrophysics of the origin and evolution of SNRs in the interstellar medium (ISM) as seen in X-rays, and compared 1D analytical solutions for different evolutionary phases of spherically symmetric SNRs. Performed imaging and spectral analysis of the soft diffuse X-ray emission of the LMC candidate (now *confirmed*) SNR J0500-6512: derived plasma properties, estimated evolutionary epochs, and classified it as a mixed-morphology, middle-aged, Type Ia remnant. Compiled comprehensive data on the observed LMC SNR population and applied probabilistic methods (maximum-likelihood fits, kernel density estimates) to study size distributions, spherical symmetry, explosion types, age–size relations, and SN energetics versus ISM environment.

Python | XMM-SAS | XSPEC | PyXspec | Statistical Analysis

**Metropolis Algorithm for an Ising Model (MSc Advanced Computational Project)** — Oct. 2022 – Feb. 2023

Numerically simulated a 2D Ising model to visualize second-order phase transitions. Implemented the Metropolis algorithm of the Markov chain Monte Carlo (MCMC) method with importance sampling and single-flip dynamics in Python, and estimated the ferromagnetic critical temperature for spontaneous magnetization from observables.

Python | Monte Carlo Simulation | Statistical Physics

### Visualizing Relativity: A Computational Approach (BSc Final Project) — Aug. 2019 – Jan. 2020

Surveyed visualization methods for special relativity with an emphasis on computerized simulations, and implemented a virtual-camera model in a Unity game to demonstrate relativistic effects.

Unity | Computational Physics | Scientific Visualization

## Publications & Reports

### Vision-Language Model Detection of Interstellar Medium Structures — In preparation

*V. Shukla, et al.* (Target: Astronomy & Astrophysics; ADASS XXXVI). Developing a scalable multimodal machine learning framework for automated detection and classification of bubble-like ISM structures including supernova remnants, HII regions, stellar wind bubbles, and planetary nebulae, by fine-tuning open-weight vision–language models on multiwavelength survey data to produce reproducible detection pipelines and publishable ISM catalogues.

Multimodal ML | Vision-Language Models | Astrophysical Surveys

### Colorism in Multimodal AI — Mar. 2026

Paper

*R. G. Maurya, V. Shukla, S. Panat* (Student Research Workshop, EACL 2026). Co-authored "An Empirical Exploration of Socioeconomic Linguistic Bias in Text-to-Image Generation," showing that GPT-5 Image-mini, Gemini 2.5 Flash-Image, and Grok-2 Image tend to produce lighter skin tones for high-income occupations – evidencing measurable socioeconomic bias in multimodal generative AI.

Generative AI | Vision-Language Models | AI Bias

### Simulating Misinformation Propagation in Social Networks using LLMs — Nov. 2025

arXiv:2511.10384

*R. G. Maurya, V. Shukla, et al.* (LASS Workshop, ACM CIKM 2025). Auditor–node framework simulating how biases, ideologies, and cognitive heuristics drive misinformation evolution and factual degradation across networks of persona-LLMs. **LASS Outstanding Paper Award**; under review at JCST after first revision.

Large Language Models | Multi-Agent Simulation | Computational Social Science

- **Wolf-Rayet Stars as Core-Collapse Supernovae Progenitors** (*review paper*, Aug. 2023) — 5-page review of supernovae (notably the Type Icn class) summarizing SN 2022ann, focusing on massive WR stars as candidate progenitors.
- **Cosmic Radiation** (*advanced laboratory report*, Nov. 2022) — time/energy-spectra and coincidence analysis with a $^{60}$Co source and NaI scintillator; photon attenuation, effective speed of light, and angular dependence of atmospheric muons.
- **Probing the ISM by High-Resolution X-ray Spectroscopy of LMXBs** (*observing proposal*, Sep. 2022) — proposed XMM-Newton RGS observations of two low-mass X-ray binaries to constrain Fe-bearing interstellar grain composition.
- **Chemical Composition of Interstellar Dust in the Perseus Molecular Cloud** (*observing proposal*, Feb. 2022) — proposed a mid-IR spectroscopic survey with NASA IRTF MIRSI to ascertain olivine–pyroxene silicate stoichiometry.
- **Air Pollution in Pune** (*BSc statistics practical*, Feb. 2019) — pollutant assessment across regions and seasons using time-series analysis, ANOVA, regression, and hypothesis testing.
- **Undergraduate Enrolments in North India** (*BSc statistics practical*, Mar. 2018) — statistical analysis of male/female undergraduate admissions across 14 north-Indian states.

## Interests & Skills

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| **Specializations** | (Observational > Numerical > Theoretical) Astrophysics & Astroparticle Physics: interstellar medium, dust, supernovae & remnants, cosmic rays; X-ray data analysis, MHD numerical simulations, statistical analysis; multimessenger & high-energy astrophysics |
| **General** | Data Science, Machine Learning, and Generative Artificial Intelligence |
| **Other** | Academic, technical, and creative writing; data analytics & visualization; research & development |
| **Programming** | Python *(good)*, C & C++ *(basic)*, R, isis, Xspec, XMM-SAS |
| **Libraries** | NumPy, pandas, matplotlib, SciPy, Astropy, scikit-learn, JAX, PyXspec |
| **Applications** | LaTeX *(expert)*, OriginLab, Microsoft Office, Git, Linux, gnuplot, HEASARC (ftools, fv, ds9) |
| **Languages** | German *(CEFR B1)*, English *(C1–C2)*, Hindi *(native)* |
| **Sports** | Chess, Badminton, Hiking |

## Workshops & Events

- **Mar. 2026** — Presented our paper and poster at the Student Research Workshop, EACL 2026.
- **Mar. 2026** — Participated in the Young Astronomers Meeting, CAMK PAN, Warsaw.
- **Nov. 2025** — Presented our paper at the 1st Workshop on LLM Agents for Social Simulation (LASS), ACM CIKM 2025.
- **Jun. 2025** — Attended workshops and presented my MSc research at the "junge AG" Summer School, Potsdam.
- **Feb. 2025** — Defended my Master's Thesis in the colloquium at Dr. Karl Remeis-Sternwarte, Bamberg.
- **Oct. 2024** — Supported the Open Day of the Bamberg Observatory for public outreach; visited the Thüringer Landessternwarte Tautenburg for a 3-institute conference.
- **Sep. 2024** — Participated in the Annual Astronomische Gesellschaft (AG) Meeting, Universität zu Köln.

- **Jul. 2024** — Attended the FRANCI 2024 Meeting at ECAP, FAU Erlangen-Nürnberg.
- **Feb. 2024** — 3-day excursion to the CERN facilities in Meyrin, Geneva, with the FAU Physics faculty.
- **Oct. 2023** — Participated in the FRANCI 2023 Meeting at Julius-Maximilians-Universität Würzburg.
- **Jun. 2023** — Volunteered for BMBF's Wissenschaftsjahr 2023 exhibitions in Bamberg.
- **Mar. 2023** — Presented a seminar on the Taurus Molecular Cloud for *Interstellar Medium* at Dr. Karl Remeis-Sternwarte.
- **Feb. 2023** — Gave a talk on the ISM around the Sun for the *Seminar on Particle Physics & Astrophysics* at ECAP.
- **Mar. 2021** — Joined the online workshop *Fundamentals of Gaseous Halos*, KITP, UC Santa Barbara.
- **Feb. 2019** — Attended the 2-day conference *Frontiers in Physics XII*, Fergusson College, Pune.

## Selected MSc Courses

Particle and Astroparticle Physics *(advanced experimental)*; Quantum Field Theory in Condensed Matter *(advanced theoretical)*; and electives: Introduction to Astroparticle Physics, Galaxies & Cosmology, X-ray Astronomy II, Extreme Astrophysics, Interstellar Medium, and the Particle Physics & Astrophysics seminar. German as a Foreign Language B1.1 *(general language course)*.

## Awards & Certificates

- **Nov. 2025** — LASS Outstanding Paper Award (co-author), LASS Workshop, ACM CIKM 2025.
- **Aug. 2024** — Member of the Astronomische Gesellschaft and the European Astronomical Society.
- **2024** — Abschlussstipendium, awarded to a graduating international student with very good grades by the Bavarian government.
- **2020** — "A. Gondhalekar Prize" for the Best Project in Physics (BSc 3rd year).
- **2018–19** — First place, Physics Presentation Competition (BSc 2nd year); consolation prize, Physics Poster Competition (BSc 1st year).

## Academic Referees

Prof. Dr. Manami Sasaki
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