ADVIK GUPTA

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EDUCATION

Indian Institute of Technology (BHU), Varanasi   *Dec 2021 – Present*
B.Tech. + M.Tech. in Engineering Physics   ***9.49/10***
(Honors - Astrophysics)   *Dept. Rank 1*

RESEARCH INTERNSHIPS

Degenerate RGB Stars as Probes for Constraining Core Overshoot During   *May 2025 – Jul 2025*
Main Sequence

Supervisor: Prof. Sébastien Deheuvels, IRAP (Institut de Recherche en Astrophysique et Planétologie), Toulouse, France (Remote)

- Identified a degenerate RGB branch for the *Kepler* field.

- Tested the input physics and the initial parameters to model the degenerate branch using MESA.

- Conducted simulations with MESA to reproduce the observed degenerate branch by modeling the *Kepler* Synthetic data and the observed degenerate branch, using varying step overshoots.

- Constrained the core overshooting parameter (α_{OV}) to the range 0.15–0.2 for red giants with masses between 1.6 and $1.8\,M_\odot$, with results indicating a tendency toward values closer to 0.2.

Quantifying Selection Effects in Galactic Surveys   *May 2024 - Aug 2024*

Supervisor: Prof. Luca Casagrande, Research School of Astronomy & Astrophysics, ANU, Australia   [ ]

- Developed a code to calculate the probability of observing a star given its age, distance, and metallicity.

- Simulated the Milky Way galaxy using the GALAXIA code. Subsequently, sampled stellar populations in terms of age, [Fe/H] and distance.

- Using sampled distributions and probability calculation code, we simulate the synthetic PDF for age and [Fe/H], effectively modeling a section of the sky as observed in surveys. Currently, the code is optimized for *GALAH* and *GAIA* surveys.

- Developed this framework into a computational pipeline named OPACOS (available on my GitHub).

PROJECTS

Implementation of Epsilon Difference Calculation in *PLATO* MSAP5-16   *Feb 2025 - Present*

Project under Prof. Kuldeep Verma, Department of Physics, IIT (BHU) Varanasi, India

- Verified the compatibility of the Epsilon differences calculation code of BASTA with the GlitchPy code which calculate glitches and ratios.

- Extended the functionality of GlitchPy by implementing Epsilon difference calculations.

- Streamlined GlitchPy into the current MSAP5-16 sub-module, aligning its architecture with the initial version of MSAP5-16.

- The code is now ready to be deployed and is with the *PLATO* team now.

Measuring Helium Abundance in Subgiant Stars using Asteroseismology   *May 2023 - Dec 2024*

Honors Project under Prof. Kuldeep Verma, Department of Physics, IIT (BHU) Varanasi, India

- Utilized latest oscillation frequencies of G5 Subgiant μ Herculis from the Hertzsprung SONG Telescope, to conduct glitch analysis using GlitchPy package, and calculate helium glitch parameters.

- With the help of a dense grid made using GARSTEC and ADIPLS, we modelled the G5 Subgiant μ Herculis by fitting metallicty, effective temperature, frequencies and glitch parameters using BASTA.

- The inferred values for mass and radius were consistent with the earlier studies conducted on the target star. We also found glitch fitting to improve the surface helium abundance for our models.

- Conducted an in-depth study of the helium glitch location in the Γ_1 profile, thereby addressing the ongoing debate and confirming its origin at the peak instead of the dip.

Conferences & Posters

Glitch analysis and asteroseismic modeling of subgiant μ Herculis: *Jul 2025*
confirming and interpreting the Γ_1 peak as the helium glitch
9th TESS/16th Kepler Asteroseismic Science Consortium Workshop, Vienna, Austria (Virtual Participation)

Detailed asteroseismic modeling and precise inferences of the physical *Feb 2025*
properties of the benchmark subgiant μ Herculis
43rd Annual Meeting of the Astronomical Society of India (ASI), Rourkela, India

Publications

- Paper titled "Glitch analysis and asteroseismic modeling of subgiant μ Herculis: confirming and interpreting the Γ_1 peak as the helium glitch" *Submitted to MNRAS journal* (**arXiv link on my website**).

Skills

- **Programming:** Python, C, IDL, MATLAB, Machine Learning, Deep Learning
- **Computational Tools:** MESA, BASTA, GARSTEC, GALAXIA, ALextin, batman, GlitchPy
- **Soft Skills:** TOEFL (115/120), Critical thinking, Problem Solving, Teamwork, Content Writing

Achievements & Honors

- Cleared the first round of the NSSC Case Study, which is an astronomy based competition event organized by IIT Kharagpur.

- Secured a rank among the top 0.25 % of 1 million plus students in Joint Entrance examination (JEE) .

- **ANU FRT Scholar:** Awarded the 2024 ANU Future Research Talent (FRT) Scholarship to conduct research at the Australian National University during the summer of 2024.

- **DAAD-WISE Scholar:** Awarded by the German Academic Exchange Service (DAAD) to carry out research in Germany in the summer of 2024.

Relevant Coursework

- Solar and Space Plasma Physics
- Mathematical Methods
- Practices of Engineering Physics
- Fourier Optics
- Magnetohydrodynamics
- Introduction to Astronomy & Astrophysics
- Computational Physics
- Relativistic Electrodynamics
- Classical Mechanics
- Simulation Methods in Statistical Physics

Position of Responsibility

Co-Convenor *Apr 2024*
Yuri's Night, Astronomy Club, IIT (BHU) Varanasi

- Conducted the Astronomy Festival at IIT (BHU), featuring astronomy-based events and hackathons.

- Managed and hosted workshops and guest talks, inviting renowned scientists.

Senior Core Team Member *Jul 2023 - Present*
Research Community, IIT (BHU) Varanasi

- Made research opportunity information available and assisted other students in their research path.

- Provided support and aid in the coordination and seamless execution of club events, including activities such as guest lectures and more.

Senior Core Team Member *Sep 2022 - Present*
Astronomy Club, IIT (BHU) Varanasi

- Authored articles on recent developments in astronomy and astronomical events.

- Assisted and managed different events of our club like induction, observatory session.

Extracurricular

- Represented IIT (BHU) with my band as a drummer at Inter IIT cultural meet 2023, IIT Kharagpur.

- **Rock School London**: Successfully completed and passed the formal graded assessment for Drums, achieving qualification up to grade 3 through the Rock School London (RSL) examinations. Additionally, obtained a Level 1 Award in Popular Music Performance.