Prakhar Bansal

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prakharbansal

Education

2020 – 2022* **Indian Institute of Technology Bombay, India**
B.Tech *Electrical Engineering* — 9.29 CPI
Minor *Physics* — 10 CPI

2018 – 2020 **Yogiraj Public School, Kota, Rajasthan, India** — 97%
Intermediate/+2

2008 – 2018 **St. Peter's Sr. Sec. School, Bharatpur, Rajasthan India** — 97%
Matriculation

Research Interests

My research interests lie mainly in the domain of Cosmology and Astrophysics. I'm interested in working in all aspects theory, simulations as well as observations. A few particular topics about which I'm quite curious are Particle Physics of the Early Universe, Reionization and CMB anisotropies. I am also looking forward to work in Gravitational Waves. I have completed Physics Courses this autumn semester: Gravitaional Wave Astronomy, Quantum Mechanics II (Perturbative Quantum Theory) and Quantum Mechanics III (Relativistic QM and Introductory QFT).

Publications

2022 **Detection of mutant peptides of SARS-CoV-2 variants by LC/MS in DDA approach using an in-house database** (Under Review) .

Research Internship

2022 **National Centre for Radio Astrophysics, Pune**
Resolved Star Formation using MaNGA survey
Guide: Prof Yogesh Wadadekar | NCRA-TIFR

- Studied aspects of extragalactic astronomy like **Galaxy Morphology, Evolution and Clusters and High Redshift Galaxies** from Peter Schneider's book Extragalactic Astronomy and Cosmology
- Currently reading about various Galaxy surveys like **MaNGA** Survey, and **GALEX-SDSS-WISE** Catalog (GSWC) and familiarising with integral field spectroscopy analysis pipelines like **Pipe3D**
- Aiming to study resolved star formation in odd galaxies like **Blue Ellipticals, Red Spirals and star forming Sos** using above datasets
- Attended introductory Radio Astronomy Lectures on **Pulsars, AGNs, Interferometry** and visited Giant Meterwave Radio Telescope (**GMRT**) Observatory located in Pune

Key Projects

2022 **Optimal Parameter Constraints for Dark Energy Models** Github Repo Link
Guide: Prof Bharat Ratra | Kansas State University
• Read about various Cosmological Tests including **Gravitational Lensing, Bolometric Distance Modulus, Galaxy Count**. Studied three dark energy models: Λ**CDM**, **XCDM** and ϕ**CDM**
• Applied Markov Chain Monte Carlo (**MCMC**) simulations using **emcee** library to constrain model parameters $\Omega_b h^2$, $\Omega_c h^2$, Ω_Λ, H_o, ω_x for Λ**CDM** and **XCDM** models using **H(z)** and **BAO** data
• Aiming to extend the parameter constraints analysis using **Supernova IA, Quasar Angular Size and H II starburst galaxy** data for ϕCDM model by employing **MontePython** and **CLASS** code

Detecting Dark Matter in Cosmological 21cm Signals Google Drive Link
Guide: Prof. Vikram Rentala | IIT Bombay
• Learnt about applications of **Boltzmann equation** in tracking abundance of various particle constituents like **Baryons**, Cold Dark Matter (**CDM**) Particles, **Neutrinos** and **Photons** of the universe
• Studied about **inhomogeneities in matter, growth of structure** in the universe in the linear regime and the **inflation theory**. Currently reading about **CMB anisotropies**
• Familiarised with basics the **21-cm cosmology** field and presented the work as a **seminar**. Aiming to investigate **21cm** signals from the epoch of cosmic dawn for **dark matter detection**

Gravitational Waves from Freely Precessing Rigid Bodies Google Drive Link
Course Project | PH 821: Gravitational Waves Physics and Astronomy
Guide: Prof. Archana Pai | IIT Bombay
• Performed analytic calculations for the Gravitational Wave **(GW) amplitude** corresponding to plus (+) and cross ($\times$) polarisation and **power radiated** in GWs from a rigid body precessing about its axis
• Estimated the order of magnitude of Gravitational Waves emitted from **pulsars** and presented the work as a **seminar** for the course

2021 **Mutant Peptide Analysis in Covid-19 Affected Indian Patients**
Guide: Prof. Sanjeeva Srivastava | IIT Bombay
• Completed the 21 day Proteomics Internship Orientation Program and learnt about various proteomics approaches like **gel based, label based** and **targeted proteomics**
• Trained in various **Bioinformatics tools** like Maxquant, Reactome and Proteome Discoverer
• Written python scripts to extract specific Sars-Cov-2 protein sequences and **identify correct frame** from a three frame translated proteomic data of Covid-19 affected Indian Patients

Scholastic Achievements

2020 Secured **All India Rank 240** in **JEE Advanced** out of 240 thousand eligible candidates
2020 Achieved **All India Rank 150** in **JEE Main** out of 1.13 million candidates
2021 Selected for **National Initiative for Undergraduate Science(NIUS 2021), Physics**, conducted by HBCSE-TIFR, along with 80 other students from all over India
2018 Bagged All India Rank **27** and received the **Kishore Vaigyanik Protsahan Yojana** Fellowship
2020 Selected for OCSC camp for **International Chemistry Olympiad** along with 45 other students
2018,19 Qualified for **Indian National Astronomy Olympiad** conducted by HBCSE
2016 Among the top **310** students selected for **Indian National Junior Science Olympiad**(INJSO)
2018 Recipient of the **National Talent Search Examination (NTSE) Scholarship**, awarded by NCERT

Other Projects

2021 **Elementary Particle Physics** Project Report
Summer of Science | MnP Club, IIT Bombay
• Studied the properties of elementary particles, their classification schemes and their interactions with the help of **Feynman Diagrams** and the **Conservation Laws** governing these interactions
• Learnt about Noether's theorem and some fundamentals of group theory focussing mainly on **Lie Groups** and explored properties of certain lie groups like **SU(n), SO(n) and SL(n,C)**
• Looked into **Flavor Symmetry** to understand **Quark Models** like baryon decuplets and meson nonets by studying the combinations of up, down and strange quarks to form mesons and baryons

Correcting Stellar Aberration Using Curve Fitting Github Repo Link
Krittika Summer Project 2.0 | Krittika ,The Astronomy Club, IIT Bombay
• Obtained the relation between **Apparent Ecliptic Coordinates** of a star and its **True Ecliptic Coordinates** using relativstic velocity addition
• Computed the true position of a star using **Curve-Fitting**, given its apparent position over an year

n3URL Github Repo Link
Institute Technical Summer Project(ITSP) | Institute Technical Council, IIT Bombay
• Implemented a **Convolutional Neural Network** and trained it on **Electroencephalogram data** to classify EEG signals based on whether the user is thinking about left or right movement
• Used simulated EEG signals to control movement in the **Breakout** game with **75 % accuracy**
• Selected as one of the **top 6** teams among **50** teams that participated in the competition

Convolutional Neural Networks and Its Applications Github Repo Link
Seasons of Code | WnCC, IIT Bombay
• Implemented the **ResNet50** architecture with **transfer learning** from the Imagenet project and used it for the multilabel classification problem of classifying movie posters based on their genres
• Achieved **18% accuracy** for predicting all genres and **80% accuracy** for predicting a single genre
• Learnt about various types of Convolutional Neural Networks and how to implement them in Python using **Tensorflow**

Teaching and Mentorship

2021 **Summer of Science 2022 Mentor | Cosmology and Dark Matter**
Maths n Physics Club | IIT Bombay
• Mentored 4 students to complete a reading project covering a range of topics like Special and General Relativity, Basics of Cosmology and some theoretical ideas about Dark Matter

Teaching Assistant | PH 108: Basics of Electricity & Magnetism
Prof Alok Shukla | Dept. of Physics, IIT Bombay
• Discussed **weekly problem sets**, oversaw the logistics of conducting weekly tutorial quizzes

Teaching Assistant | PH 107: Quantum Physics and Application
Prof S. Shankaranarayanan | Dept. of Physics, IIT Bombay
• Mentored a batch of **38** students, discussed weekly **problem sets** and **g**raded exam papers

Technical Skills

Programming Languages	Matlab, Mathematica, C++, Python, VHDL, LaTeX, R
Software	Git, Quartus, GNU Radio,
Libraries	Emcee, Scipy, Astropy, Biopython, Tensorflow, Keras, Pandas, Matplotlib

Courses Undertaken

Physics	Gravitational Wave Physics and Astronomy, Quantum Mechanics III, Quantum Mechanics II, General Relativity, Statistical Physics, Classical Mechanics, Basics of Electricity and Magnetism, Quantum Physics and Application
Electrical Engineering	Communication Systems, Electromagnetic Waves, Control Systems, Power Engineering 2, Electronic Devices and Circuits, Power Engineering 1, Digital Systems, Analog Circuits, Probability & Random Processes, Signal Processing
Mathematics	Linear Algebra, Complex Analysis, Multi-variable Calculus, Ordinary Differential Equations, Partial Differential Equations

Extracurriculars

- 2022 Among the top 8 performers of the institute to perform in Annual Standup Comedy Showcase
- 2021 Volunteering at **Vriskh NGO** for teaching **Chemistry** and **Physics** to high school students for various competitive examinations like JEE Main, JEE Advanced , KVPY and Olympiads
- Received **Special Mention** in **Laughter Riots** conducted by Comedy Cons, IIT Bombay
- Completed one year of **Dramatics** training under NSO, IIT Bombay
- Participated in RascionX conducted by Chemistry Club, IIT Bombay and cleared the Prelims Round