

Vedant Prakash Shenoy

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Time Domain Astronomy. Observational Astronomy. Galactic Dynamics
Amateur Astronomer interested in Astronomy Outreach and Astrophotography

Education

- 2017–present **B.Tech, IIT Bombay**, Mumbai, Maharashtra, India.
B.Tech in Engineering Physics CPI: 9.09/10.00
- 2015–2017 **Higher Secondary, Kuriakose Elias Higher Secondary School**, Kottayam, 97.42%.
- 2015 **High School, Girideepam Bethany Central School**, Kottayam, 10.0/10.0.

Research Experience

- Sept. 2019–Present **Development of CIFT: CZTI Interface for Fast Transients**,
Guide : Prof. Varun Bhalerao, IITB.
 - Reviewed methods to detect GRBs in noisy data, and calculating upper limits for non-detections.
 - Conducted searches for Electromagnetic Counterparts to Gravitational Waves triggered by LIGO/Virgo Public Alerts, and blind searches to detect possible GRB candidates in AstroSat CZTI data.
 - Currently working on automating triggered searches and optimizing and integrating codes for transient detection by CZTI for both triggered and blind searches.
 - Published 19 GCNs for AstroSat CZTI detections and upper limits
- June 2019–Present **Determining Accurate Rotation Curves of the Milky Way using GAIA**,
Guide : Prof. Subhabrata Majumdar, TIFR.
 - Studied methods to reconstruct rotation curves of the Milky Way given the Line of Sight (LOS) velocities of tracer objects, and indirect measurement of the distances using standard candles like Cepheids and RR Lyrae
 - Cross-matched between catalogues of Cepheids and Gaia to get accurate 3-D mapping of velocities of the tracers, and constructed rotation curves of the Milky Way up to ~ 20 kpc, using Classical Cepheid tracers.
 - Using various tracers of Galactic Rotation, with spectroscopic parallaxes from SDSS and proper motions from Gaia, and using Jean's Equation, constructed rotation curves and measured velocity anisotropy parameters up to 50 kpc from the Galactic Center.
 - Current work is towards finding new data sets to cross-match with Gaia to estimate anisotropies farther out in the galactic halo.

Workshops and Camps

- Dec. 2018 **GROWTH Winter School, IIT Bombay**.
 - Attended the GROWTH (Global Relay of Telescopes Watching Transients Happen) Winter School, a three-day intense program with short lectures followed by interactive hands-on sessions in python, using several packages and software including **SciPy**, **Astropy** and **SAO ds9**
 - Introduced to techniques for multiwavelength follow up observations of transient events such as gamma-ray bursts, supernovae, gravitational wave events including localization, photometry, and light curve analysis
 - Studied the basics of observation planning using astroplan, astroquery, and image reduction and subtraction using astropy
- Dec. 2017 **Astronomy Nurture Camp, TIFR, NIUS**,
Multiwavelength investigation of star forming activities in IRAS 16164-5046.
 - Participated in Astronomy Nurture Camp, held at IIST, Thiruvananthapuram, where 4 groups of 15 undergraduates worked together under supervision to **study star formation** in a radio source IRAS 16164-5046
 - GMRT data of the source at 610 and 1280 MHz was used to make an image using the **Astronomical Image Processing Software (AIPS)**, which was subsequently used to find the single ZAMS spectral type of the OB stars which were proposed to be the ionizing source for the HII region under investigation.
 - Further, by comparing the intensities at different regions in multiple wavelengths, we were also able to locate regions of non-thermal emission.
- Apr.–May 2017 **Astronomy Orientation-cum-Selection Camp, HBCSE**.
 - Among 50 students selected to attend a three week long summer camp aimed at introducing students to astronomy and astrophysics, and to select participants for the International Olympiad for Astronomy and Astrophysics
 - Attended lectures on various facets of astrophysics, delivered by distinguished faculty from around the nation, and participated in tutorial sessions to solve problems
 - Underwent training for night sky observation, with alt-azimuth and equatorial telescopes

Key Course Projects

- Autumn 2018 **Orbital Resonance and Chaos in the Solar System, IIT Bombay,**
PH 542 : Non-linear Dynamics, Guide : Prof. Punit Parmananda.
- Studied the reduced three body problem in gravitational systems, Lagrange Points and Roche lobe overflow
 - Analyzed stability of Lagrange points and orbits around the Lagrange points L4 and L5
 - Studied orbital resonances in the solar system and its role in stabilizing and destabilizing certain orbits in the solar system with examples like the Kirkwood Gaps, Cassini divisions and Laplace resonance of the moons of Jupiter
- Autumn 2018 **Analysis of Data from the Open Government Data Platform, IIT Bombay,**
EP 219 : Data Analysis and Interpretation, Guide: Prof. Vikram Rantala.
- As part of a team of 4, analyzed data taken from the Open Government Data (OGD) Platform
 - Data pertaining to socially relevant causes were used, such as the teacher-student ratios in different geographic areas, fraction of Open Defecation Free (ODF) districts in each state were considered
 - Additional data on crime and unemployment rates in each state were also considered, and correlations among different data-sets were used to study trends

Mentoring Experience

Krittika Summer Projects

2 month-long coding projects in Python

- May–July 2020 **Making a Synthetic Analemma,**
Krittika: The Astronomy Club of IIT Bombay.
- Mentored a team of 4 in constructing artificial analemma for a general orbit of a planet around a host star.
 - Properties of the synthetic analemma (width, orientation, asymmetry) were studied by scanning parameter space. Using *Blender*, an animation was made to illustrate these changes.
 - Final Report:
- May–July 2020 **Understanding Binary Star Systems,**
Krittika: The Astronomy Club of IIT Bombay.
- Mentored a team of 10 in studying and modelling light and velocity curves of Binary Star Systems.
 - The project included simulating light and velocity curves for eclipsing binaries, spectroscopic binaries (SB1 and SB2) as well as circumbinary (2+1 and 2+2) systems, as well as further reading on topics such as Contact Binaries, the Shapiro delay in Pulsar Timing studies and Mass-Transfer.
 - For several of these systems, animations were made using *Blender*, which can be found here.
 - Final Report:
- May–July 2020 **Interface for a Star Hopping Guide,**
Krittika: The Astronomy Club of IIT Bombay, Co-mentors: Chaithanya Naik, Pratham Patil.
- Mentored a team of 6 in constructing interfaces to display and edit star hops to find Deep Sky Objects.
 - A database was constructed combining the *Hipparcos*, *Yale Bright Star* catalogues. Custom plotting functions were made using projections from the *basemap* toolkit for *matplotlib*, taking into consideration telescope specifications. The final interface was constructed using *pygame*.
 - The working interface can be used at krittika-iitb.com/hops
 - Final Report:

Krittika Winter Projects

6 week-long learn-by-doing projects aimed at freshmen and sophomores

- Dec. 2019 **Studying HR Diagrams,**
Krittika: The Astronomy Club of IIT Bombay.
- Mentored a team of 5 in learning basic data analysis and plotting using Python by making and analyzing HR Diagrams.
 - The project consisted of reading about the significance of HR Diagrams, and using them for distance measurements by main-sequence matching
 - Final Report:
- Dec. 2019 **Gravitational Simulations,**
Krittika: The Astronomy Club of IIT Bombay.
- Mentored a team of 4 in studying the reduced gravitational 3-body problem
 - The project consisted of using numerical simulations to integrate the system and study points of equilibrium (Lagrange Points) in the reduced three body system.
 - Final Report:

Academic Achievements

- Dec. 2018 **Gold Medal in Inter IIT Tech Meet 2018**, IIT Bombay.
Gold Medal in Inter IIT Tech Meet 2018, conducted in IIT Bombay, as part of a team of four, in the event 'Star Cluster Identifier', where we used scientific computing python packages including **NumPy** and **matplotlib** to analyse a given dataset of a globular cluster to infer its properties such as half-light radius and age using colour-magnitude diagrams, and to cross-match known X-ray sources with stars in the region, assumed to be off the main-sequence
- April 2018 **AP in Linear Algebra**, IIT Bombay.
 Among 4 students out of 937 awarded the AP grade for Advanced Performance in Linear Algebra in Spring 2018
- 2017 **Indian National Olympiads, HBCSE-TIFR.**
 Was selected to appear for Indian National Olympiads in Physics (**INPhO**), Chemistry (**INChO**) and Astronomy(**INAO**), nation-wide olympiads for selecting students for the International Science Olympiads
- 2017 **Various Engineering Entrance Examinations.**
- **All India Rank of 763** out of 160,000 in **JEE(Advanced) 2017**, a nation-wide entrance exam for admittance to top institutes in India, including the IITs, IISc, IIST and IISERs
 - **All India Rank of 98** out of 1.2 million in **JEE (Mains) 2017**, national entrance exam for engineering institutes in India, and through which students are selected for JEE(Advanced)
 - **State rank of 2** out of 72,000 in the Kerala Engineering Entrance Examination 2017
- 2015, 2016 **Kishore Vaigyanik Protsahan Yojana(KVPY), IISc.**
 Selected for the KVPY fellowship. awarded to high school students with keen interests in research in the basic sciences in 2015 and 2016, on the basis of a written test and an interview, with **All India Ranks 299 and 35** respectively and attended the **Vijyoshi Camp** in **IISc Bangalore** in 2016
- 2015 **National Talent Search Examination (NTSE).**
 National Level Examination to select **1000 students** nationwide for a Scholarship of Rs.2000 per month

Position of Responsibility

- Apr. 2019– **Manager**, Krittika-The Astronomy Club of IIT Bombay,
 Apr. 2020 Institute Technical Council, IIT Bombay.
- Lead a team of 6 conveners, catering to the community of astronomy enthusiasts in the institute, and to popularize astronomy in the institute
 - Coordinated and planned night-sky observation sessions, lectures, competitions and programming workshops, to popularize astronomy in the institute
 - Conceptualized and organized the Krittika Winter Projects, a learn-by-doing project to introduce participants to Python for Astronomy.

Computer skills

Languages	Python, Bash, HTML5, \LaTeX	OS	Linux, Windows
Scientific	Numpy, Scipy, Astropy,	Visualization	Matplotlib, Seaborn, Origin
Python	Pandas, AstroML, Numba		
Others	SAOImage DS9, AIPS		

Key Courses

Physics	Classical Mechanics, Statistical Physics, Electromagnetic Theory, Introduction to Special Relativity, Quantum Mechanics I and II, Astrophysics, General Theory of Relativity, Non-linear Dynamics
Math	Numerical Analysis, Differential Equations I and II, Complex Analysis, Real Analysis, Linear Algebra
Math	Linear Algebra, Multivariate Calculus, Complex Analysis, Numerical Analysis, Differential Equations I and II
Other Courses	Data Analysis and Interpretation, Probability and Random Processes, Computer Programming and Utilization, Introduction to Electronics, Digital Systems, Organic, Inorganic and Physical Chemistry
Electronics Labs	Microprocessors (Arduino), Digital Electronics, Analog Electronics , Basic Electronics