

I am currently pursuing a Master's degree in Astronomy, with my thesis work's primary focus on Cosmology. My academic journey saw a transition from a Mechanical Engineering background to the realm of Physics, a change driven by my deep passion for the subject. This shift has been personally fulfilling, igniting my dedication to further explore the mysteries of the universe and contribute to its ever-expanding knowledge.

## Education

### **Indian Institute of Technology (IIT), Indore**

Master of Science in Astronomy. Performance – 8.34/10 CPI (two semesters)  
Department of Astronomy, Astrophysics and Space Engineering (DAASE)

July 2022 – Present  
Indore, India

### **Indian Institute of Technology (IIT), Madras**

Dual Degree - B.Tech in Mechanical Engineering &  
M.Tech in Thermal Engineering. Performance – First Class  
Department of Mechanical Engineering

August 2017 – June 2022  
Chennai, India

## Research Experience

### **Studying the impact of different reionization source models on simulated HI 21-cm images using Wavelet Scattering Transform (WST) – [Detailed Report](#)**

May 2023 – Present

A year-long Masters thesis project under the guidance of Dr. Suman Majumdar – DAASE, IIT Indore

Indore, India

- > Studied the physics incorporated in the different EoR source models considered and the simulation techniques used to generate the 21-cm coeval cubes
- > Performed WST analysis on simulated 21-cm images of UV, Soft Xray and Hard Xray photon-dominated reionization source models. Generated lightcones from the simulated models and examined the impact of lightcone effect on simulated 21cm maps with WST
- > Currently working on studying the impact of telescope effects like noise, low resolution on simulated 21cm maps with WST
- > Compared 2D WST results with 3D power spectrum and 3D Bispectrum results to establish its efficiency to capture non-Gaussian information. 2D WST outperforms 3D power spectrum, and is also more sensitive than 3D Bispectrum in some of our models
- » Skills developed: EoR Cosmology, Fourier & Wavelet Analysis, Handling Big Data, Statistical Inference

### **Particle-Mesh N-body Simulation**

March 2023 – June 2023

Project as part of Computational Methods in Astrophysics course by Dr. Suman Majumdar

Indore, India

- > Simulated Dark matter (DM) density fields using N-body simulation, generated halo catalogues and halo maps from the DM density fields using friends-of-friends (FoF) halo finder algorithm
- > Calculated Power Spectrum and Halo mass function of the simulated DM density maps and the halo catalogue respectively
- » Skills developed: N-body simulation, Cosmological parameters, equations of motion, Zeldovich Approximation

### **Markov Chain Monte Carlo Simulation (Metropolis-Hastings and Hamiltonian Monte Carlo)**

April 2023

Project part of Astrostatistics course by Dr. Suman Majumdar

Indore, India

- > Used the Markov Chain Monte Carlo (MCMC) and Hamiltonian Monte Carlo (HMC) random walk algorithms to estimate cosmological parameters from supernova Ia data and to estimate deflection parameter from the photographic plates of Eddington's 1919 eclipse expedition to confirm Einstein's General Theory of Relativity
- » Skills developed: Bayesian inference & random walk simulations to find and fine-tune the parameters for given conditions

### **Computational Fluid Dynamics (CFD) - Numerically solving PDEs using finite difference and finite volume methods**

February 2023

Project as part of Computational Methods in Astrophysics course by Dr. Bhargav Vaidya – DAASE, IIT Indore

Indore, India

- > Solved Advection equation using FTCS, Upwind, Lax Method, MacCormack method & Lax-Wandroff Schemes. Solved Isothermal Shock Tube problem using Total Variation Diminishing (TVD) slope limiters & flux limiters schemes
- » Skills Developed: Numerical methods for solving PDEs

### **Implementing selection of reactions & Quasi steady state assumptions on simulated combustion reactions using DRGEP Method**

August 2021 – June 2022

A year-long Masters thesis project under the guidance of

Chennai, India

Dr. Kritika Narayanaswami (Department of Mechanical Engineering, IIT Madras)

- > Designing an error propagation algorithm to calculate the impact of removal of desired reactant species on the combustion products using Directed Relation Graph with Error Propagation (DRGEP) approach
- » Skills developed – Thermodynamics of Combustion, Reaction Mechanisms, Error Propagation techniques used in Combustion simulations

### Plotting Geodesics on a Toroidal surface

Sep 2020 – Nov 2020  
Chennai, India

Undergraduate project as part of Classical Mechanics course by  
Dr. Kasi Swaminathan (Department of Physics, IIT Madras)

- > Solving the geodesic equation on Toroidal surface passing through any two given initial points using Runge-Kutta methods
- > 3D visualisation of the geodesic lines on a toroidal surface
- » Skills developed – General Relativity : Geodesic Equations, Numerical Methods for solving differential equations, MATLAB

## Teaching Experience

### Teaching Assistant for "Engineering Mechanics - Statics and Dynamics" course as part of National Programme on Technology Enhanced Learning (NPTEL)

Jan 2019 – April 2019

Course offered by Dr. Mahesh Panchagnula – Dept of Mechanical Engineering & Dean of Alumni and Corporate Relations (ACR), IIT Madras Chennai, India

- > Helped with the preparation of assignments, mid-term and end-term exam questions
- > Conducted bi-weekly sessions with students for doubt clarifications

## Workshops Attended

### Numerical Astrophysical Gasdynamics

March 2023

by Dr. Garrelt Mellema – Department of Astronomy, Stockholm University, Sweden

Indore, India

- > Solved hydrodynamic equations with source terms, shocks & discontinuities using Finite Difference methods, Riemann & Roe Solvers

### Search for ExtraTerrestrial Intelligence (SETI)

September 2022

by Dr. Erik Zackrisson – Department of Physics and Astronomy, Uppsala University, Sweden

Indore, India

- > Learnt about Fermi Paradox, Drake Equation, Astrobiology of life, how to identify & decode technological signals from intelligent civilisations.

## Talks

### Research Presentation and Talk – You can watch it here

September 2023

as part of Mid-semester Stage-I Thesis evaluation by DAASE, IIT Indore

Indore, India

- > I have delivered a comprehensive research presentation which offers insights into my research progress, methodologies & interesting findings, providing a deeper understanding of my thesis work till September

## Science Outreach

### Talk on "A brief history of the Universe"

October, 2023

Workshop by Astronomy Club, IIT Indore as part of "100 hours of Astronomy" project

Indore, India

### Public Stargazing and Solar Eclipse Events

IIT Indore, India

- > Organized and led engaging stargazing sessions and solar eclipse viewing events, providing the general public with memorable opportunities to explore the cosmos through telescopes, fostering curiosity & appreciation for Astronomy

## Skills

**Computational Astrophysics :** N-Body simulations, FoF Halo finder, Tools21cm, Numerical methods for solving PDEs

**Statistical Inference :** Statistics, Bayesian Inference using MCMC Analysis, Fourier & Wavelet Analysis, Time Series Analysis

**Computer Languages :** Python - Astropy, Tools21cm, Kymatio, Pytorch, Linux; MATLAB; LaTeX; Web Development - HTML, CSS

**Soft Skills :** Creative Problem Solving, Effective Communication of ideas, Collaborative Teamwork, Adaptability, Curiosity

## Other Interests

**Reading :** I learn about Neuroscience, Psychology, Biology and Philosophy through non-fiction books from leading researchers

**Strategy Games :** I play board games like chess, card games like Bridge, Go Fish etc ; PC games like FIFA, Age of Empires etc.

**Visual Storytelling :** I enjoy the art of combining story telling with cinematography & the imagination that goes into the process

**Music :** I collect good music from all over the world. I plan on learning to play violin & piano

**Cross-Disciplinary Dialogues :** I engage in dynamic and curious exchanges with fellow researchers across various scientific domains, fostering a vibrant exchange of knowledge and ideas

**Teaching & Sci-comm :** I like to teach Math and Physics by to curious people willing to learn

**Sports & Fitness :** I play badminton, football & cricket with friends. I recently started working out and I'd like to make this a habit too