

# PremVijay Velmani

SENIOR RESEARCH FELLOW · PHD

Inter-University Centre for Astronomy and Astrophysics, Pune, India - 411007

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## Research

**Cosmology and Large Scale Structure - Dark matter haloes, their evolution and distribution in the cosmic web - Galaxy formation, feedbacks and their impacts on host haloes - Cosmological (hydrodynamical) simulations, Analytical halo formation models and numerical experiments - Self-similar haloes and galaxies.**

I primarily work on an interface between cosmology and astrophysics of galaxies, trying to understand and build a physical model of the impacts of galactic astrophysical processes on the dark matter haloes. This will not only make it easier to study cosmology and dark matter physics with haloes but also helps build a consistent picture of galaxy formation and evolution.

## EXPERIENCES

### PhD Research Fellow at IUCAA

Pune, India

PI: PROF. ASEEM PARANJAPÉ

2020-present

- I have run N-body and hydrodynamics simulations of cosmological volumes using GADGET4 and SWIFT codes including some of the baryon physics.
- Using structure finding codes such as ROCKSTAR and VELOCIRAPTOR, I have made halo catalogues and merger trees.
- I have studied cosmological information such as matter power spectrum and various halo and galaxy properties in simulations.
- Besides my own simulations, I have also worked on simulations produced by large collaborations such as IllustrisTNG and EAGLE.
- I also worked on Self-similar models of halo formation and evolution along with galaxy formation.
- I also worked with semi-analytical models of dark matter haloes and galaxies and did numerical experiments with such models.

### MS Thesis at IISER Bhopal

Bhopal, India

PI: PROF. SUKANTA PANDA

2018-2019

- I worked on cosmological perturbations in an anisotropic Bianchi type-I background and its evolution in a Bouncing model.

## PUBLICATIONS

### The quasi-adiabatic relaxation of haloes in the IllustrisTNG and EAGLE cosmological simulations

<https://doi.org/10.1093/mnras/stad297>

PREMVIJAY VELMANI, ASEEM PARANJAPÉ

### Properties beyond mass for unresolved haloes across redshift and cosmology using correlations with local halo environment

<https://doi.org/10.1093/mnras/stac2605>

SUJATHA RAMAKRISHNAN, PREMVIJAY VELMANI

### A self-similar model of galaxy formation and dark halo relaxation

<https://doi.org/10.1088/1475-7516/2024/05/080>

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### Dynamics of the response of dark matter halo to galaxy evolution in IllustrisTNG

<https://doi.org/10.48550/arXiv.2407.08030>

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### The evolving role of astrophysical modelling in dark matter halo relaxation response

<https://doi.org/10.48550/arXiv.2408.04864>

PREMVIJAY VELMANI, ASEEM PARANJAPÉ

## Conferences and Events

### The Abdus Salam International Centre for Theoretical Physics

Trieste, Italy

SUMMER SCHOOL ON COSMOLOGY 2022

July 2022

- Presented a talk on "Impact Of Galaxy Formation On The Dark Matter Haloes In The Cosmic Web" at ICTP, an UNESCO organisation.

## International Centre for Theoretical Sciences

Bengaluru, India

LARGEST COSMOLOGICAL SURVEYS AND BIG DATA SCIENCE 2023

April 2023

- Worked on a mini project analysing redshift space distortion information from mock DESI data
- Presented a talk on "Impact Of Galaxy Formation On The Dark Matter Haloes In The Cosmic Web" at ICTP, an UNESCO organisation.

## Inter-University Centre for Astronomy and Astrophysics

Pune, India

PUNE-MUMBAI COSMOLOGY AND ASTRO-PARTICLE MEETING - 2

February 2024

- Presented a talk on "Interplay of baryonic galaxies and their host dark haloes - Insights from self-similar analysis"

## Tata Institute of Fundamental Research

Mumbai, India

PUNE-MUMBAI COSMOLOGY AND ASTRO-PARTICLE MEETING - 3

September 2024

- Discussion focussed meeting

## Korea Institute for advanced Study(KIAS)

Hilton yeongju, South Korea

11TH KIAS WORKSHOP ON COSMOLOGY AND STRUCTURE FORMATION

October 2024

- Presented a talk and a poster on "Interplay of galaxy formation and the evolution of dark matter haloes in the cosmic web - Dynamics of Relaxation".

## OTHER TALKS

### Inter-University Centre for Astronomy and Astrophysics

Pune, India

LAST FRIDAY TALK

November 2023

- Presented a talk on "Impact Of Galaxy Formation On The Dark Matter Haloes In The Cosmic Web".

### Inter-University Centre for Astronomy and Astrophysics

Pune, India

LAST FRIDAY TALK

March 2024

- Presented a talk on "A self-similar model of galaxy formation and dark halo relaxation".

## Education

### Inter University Centre for Astronomy and Astrophysics (IUCAA affiliated to JNU)

Pune, Maharashtra

DOCTOR OF PHILOSOPHY

July 2019 - July 2024

- Thesis title: Interplay of galaxy formation and the evolution of dark matter haloes in the cosmic web
- Thesis advisor: Prof. Aseem Paranjape

### Indian Institute of Science Education and Research (IISER) Bhopal

Bhopal, Madhya Pradesh

BACHELOR OF SCIENCE AND MASTER OF SCIENCE (BS-MS) DUAL DEGREE

August 2014 - May 2019

- Obtained a CPI/CGPA of 9.4 with major in Physics and a minor in Mathematics.
- MS thesis: "Evolution of anisotropic perturbations in bouncing cosmology" under the guidance of Prof. Sukanta Panda.

### Tamil Nadu Board of Secondary Education

Chennai, Tamil Nadu

CLASS 12 - PLUS TWO

Graduated March 2014

- **94.58 %**, Obtained **96.25 %** excluding language subjects.

### Tamil Nadu Board of Secondary Education

Chennai, Tamil Nadu

CLASS 10 - SSLC

Graduated April 2012

- **93.6 %**, Obtained **99.33 %** excluding language subjects and 100 % in science.

## Awards and fellowships

Aug.2021 **Senior Research Fellowship**, Inter-University Centre for Astronomy and Astrophysics

Pune, India

Aug.2019 **Junior Research Fellowship**, Inter-University Centre for Astronomy and Astrophysics

Pune, India

Jan.2019 **Junior Research Fellowship**, Council of Scientific & Industrial Research

New Delhi, India

Aug.2014 **INSPIRE Scholarship**, IISER, Department of Science & Technology

Bhopal, India

June.2014 **Cash Prize Award**, Second rank in 12th board exam

Chennai, India

April.2012 **SSLC cash prize award**, Centum in 10th board exam

Chennai, India

## Professional Skills

### COMPUTER SKILLS

<b>Programming</b>	Python, Bash, C, C++, IDL, Fortran, R, Wolfram, Matlab/Octave
<b>Python libraries</b>	Includes numpy, scipy, pandas, astropy, cobaya, camb, colossus, casa, h5py, sklearn, matplotlib, seaborn, getdist, pyqtgraph, vispy, vpython, pyopengl, pyopencl, pycuda, conda, mpi4py and PyQt5
<b>Simulation tools</b>	GADGET4, SWIFT, ROCKSTAR, VELOCIRAPTOR, MUSIC2-monofonIC
<b>Analytical tools</b>	Mathematica (packages xTensor, xCoba, xPert, xPand), Maple, Python sympy
<b>Operating system</b>	Linux system administration, Bash, distros including Arch Linux, Ubuntu, Fedora, RHEL, SUSE, Centos; Windows administration, Visual Studio, Powershell, Windows Subsystem for Linux; Remote administration, SSH, HPC clusters with PBS jobs scheduler and NFS storage.
<b>Markup Languages</b>	LaTeX, HTML, CSS, Markdown, MS Office/ Libreoffice
<b>Media creation</b>	Adobe Creative Cloud apps, DaVinci Resolve, Blender, Poser, Audacity

### TEACHING SKILLS

**Physics** Cosmology, Astrophysics, General relativity, Mathematical and Computational methods

## Academic Achievements

May 2022	<b>Summer School on Cosmology 2022</b> , Invited with funds by ICTP, UNESCO	<i>Trieste, Italy</i>
Jun 2018	<b>CSIR UGC NET - Physics</b> , Qualified JRF with a score of 115 and all India rank of 116	<i>India</i>
Apr 2014	<b>JEE MAIN / AIEEE</b> , Qualified with a score 190	<i>India</i>
May 2014	<b>NEET UG / AIPMT</b> , Qualified with a score of 350.	<i>India</i>
June 2014	<b>JEE ADVANCED</b> , Qualified with a rank of <b>4056</b> within OBC category.	<i>India</i>
June 2016	<b>SOLOLEARN - Python</b> , Completed with <u>certification</u>	

## Hobbies & Interests

A strongly curiosity driven and challenge seeking person.

**READING** I use the world wide web to explore various topics in both natural science and others such as history, politics, technology and sustainable development, with a rational viewpoint.

**EXPLORATION** As a foodie, I travel to various places with special focus on trying different food.

**SPORTS** Primarily football, badminton, table tennis and swimming.

**OTHER PERSONALITY** I am a foodie, experimental cook, nutritionist, fitness freak, audiophile (also amateur singer), electrical/electronics hobbyist, amateur astronomer and computer gamer.

I enjoy doing lots of home experiments driven by my own curiosity. And I can relate with prof. R Feynman that “Nearly everything is really interesting if you go into it deeply enough”. I like challenges and I don’t like doing simple things repetitively, so I keep exploring various new things. Trying to comprehend the logic behind complex things is my pleasure.

## Extracurricular Activity

<b>IUCAA open science day</b>	<i>Pune, India</i>
PRESENTED A POSTER ON BASICS OF COSMOLOGY	<i>Feb 2023</i>
<b>IUCAA open science day</b>	<i>Pune, India</i>
CREATED A VIDEO EXPLAINING PROBES OF COSMOLOGY	<i>Feb 2021</i>
<b>IUCAA open science day</b>	<i>Pune, India</i>
DEMONSTRATED CREATION OF GRAVITATIONAL WAVES	<i>Feb 2019</i>
<b>Singularity-15, IISER Bhopal</b>	<i>Bhopal, India</i>
BAD Ad HOC HYPOTHESIS ON GRAVITY AT THE COSMIC HORIZON	<i>April 2015</i>
<b>Singularity-16, IISER Bhopal</b>	<i>Bhopal, India</i>
SCIENCE EXHIBITION DEMONSTRATION OF A MEGA DOMINO EFFECT SYSTEM	<i>September 2016</i>

## **IISER Science Council**

HEAD OF ARTIFICIAL INTELLIGENCE AND ML CLUB; MEMBER OF PHYSICS, MATHEMATICS AND ASTRONOMY CLUB

*Bhopal, India*

*Aug 2014 - May 2019*

## **Astronomy and Space Technology Awareness Camp**

WORKSHOP BY SPATS OF IIT KGP

*Bhopal, India*

*April 2015*

## **Mimamsa 2015 by IISER Pune**

NATIONAL SCIENCE QUIZ

*Mumbai, India*

*January 2015*

## **Mimamsa 2016 by IISER Pune**

NATIONAL SCIENCE QUIZ

*Bhopal, India*

*January 2016*

## **School level**

COMPETITIONS

- Winner in Science quiz intra school. Got selected in science talent exam conducted by The Hindu Educational Plus.
- Winner in debate about Education System.

*Chennai, India*

## **References**

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**Prof.Dr. Aseem Paranjape**, Associate Professor, IUCAA

*Pune, India*

**Prof.Dr. Sukanta Panda**, Associate Professor, Department of Physics, IISER Bhopal

*Bhopal, India*