

NIKHIL P. S. BISHT

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RESEARCH INTERESTS

-
- Molecular Cloud Collapse
 - Galaxy Formation & Evolution
 - Cosmological Magnetohydrodynamic Simulations
 - Supervised & Reinforcement Learning

EDUCATION

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|---|--------------|
| Florida State University (FSU) , Tallahassee, FL PhD Physics, Doctoral Candidate Overall GPA: 3.54/4 – over 75 credits, Thesis: <i>Simulating Molecular Cloud Collapse with ENZO</i> Supervisor: Prof. David Collins | 2022–Present |
| Birla Institute of Technology and Science (BITS) , Pilani, India MSc. (Hons.) Physics + B.E. (Hons.) Computer Science (Transcript) Overall GPA: 9.08/10 – over 204 credits, Physics GPA: 9.6/10 – over 102 credits (<i>1st Rank, Dept. of Physics</i>) Thesis: <i>Radial Migration of Stars of Milky Way/M31 analogs in the TNG50 Simulation</i> (Master's Thesis) Supervisor: Dr. Annalisa Pillepich , Max Planck Institute of Astronomy, Heidelberg | 2017–2022 |
| Indore Public School (IPS) , Indore, India Higher Secondary Education, Overall score: 91.8 % Secondary Education, GPA 9.8/10 | 2015–17 |

RESEARCH PROJECTS

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| Machine Learning for Star Formation: Forecasting collapse of turbulent Molecular Clouds using 3D spatiotemporal models (<i>N. Bisht et al., in prep</i>) | Nov'24 - Present |
| — Prof. David Collins , Florida State University, FL <ul style="list-style-type: none">○ Generated training dataset from multiple 128^3 MHD simulations of a collapsing molecular cloud over 1 free-fall time.○ Designed and implemented a 2.1M-parameter 3D UNet with attention + Conv-GRU model for spatiotemporal forecasting of the collapse.○ Trained models on high-resolution multi-field 3D datasets (density, velocity, pressure, magnetic fields)○ Evaluated models using physics-aware metrics: L1/MSE, SSIM, PSNR (on linear densities), power-spectrum loss, mass-conservation, and extra losses focused on high-density (core) regions, and used dynamic multi-loss weighting to balance objectives. | |
| Simulating Molecular Cloud Collapse with ENZO | Nov'22 - Present |
| — Prof. David Collins , Florida State University, FL <ul style="list-style-type: none">○ Using the astrophysical magnetohydrodynamic code ENZO with adaptive mesh refinement to study the collapse of self-gravitating, turbulent molecular clouds.○ Simulations utilize sink particle formation, radiation feedback, and pseudo-Lagrangian tracer particles to evolve a periodic box of molecular gas (initially driven by solenoidal velocity patterns to get initial conditions) until stars are formed.○ Aim to understand how gas collapses until the stars are formed to make a better subgrid Star Formation model for larger galaxy simulations. | |
| Stellar Radial Migration in TNG50 Milky Way and M31-like analogs: diversity across and within galaxies (Master's Thesis) (<i>N. Bisht et al., in prep</i>) | Aug'21 - May'22 |
| — Dr. Annalisa Pillepich , Max Planck Institute of Astronomy, Heidelberg. | |

- Investigate 198 Milky-Way/M31 analogs in [TNG50](#), a set of large, Cosmological Magnetohydrodynamic simulations to quantify stellar Radial Migration.
- Observe an average outward migration rate of 0.843 kpc/Gyr and an average inward migration rate of 0.520 kpc/Gyr for stars in the solar neighbourhood.
- Galaxies with a greater number of spiral arms have a higher migration rate, whereas the effect of the presence or absence of a bar is comparatively negligible.

Modelling Neutron Star Parameters Using Neural Networks

[\(GitHub repo\)](#) ([Report](#))

Jul'20 - Dec'20

— Dr. Kinjal Banerjee, BITS Goa.

- Using Bayesian Neural Networks to predict Neutron Star properties (NS mass, NS radius and Tidal deformations) from a given set of Nuclear Matter Parameters like symmetry energy, skewness coefficient at the saturation density which uniquely define an Equation of State

Dark Matter Power Spectrum Modelling at High Redshift ([Report](#))

May'19 - Jul'19

— Dr. Aseem Paranjape, Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune.

- Implemented and compared cosmological perturbations under various numerical integration techniques in python, namely Eulerian linear, Eulerian non-linear, and Lagrangian linear.
- Simulated 20^3 particles in a periodic box using Zel'dovich Approximation with a custom written Discrete and Fast Fourier Transform in python and visualised the evolution of Large Scale Structure.

Modelling Milkdromeda ([Report](#))

Jun'18 - Dec'18

— Dr. Tarun Kumar Jha, BITS Goa.

- Modeled mass and density profiles of Baryonic and Dark Matter content (using polynomial regression on VERA observation data) of Milky Way and M31 galaxies, and the possible merger galaxy, Milkdromeda

N-Body Simulation ([GitHub Repo](#))

Aug'17 - Apr'18

- Implemented the Barnes-Hut algorithm and simulated star cluster dynamics.

Mass assembly of massive galaxies and intra-cluster light

[\(GitHub\)](#) ([Reports](#))

Mar'20 - May'20

— Dr. Annalisa Pillepich, Max Planck Institute of Astronomy, Heidelberg.

- Worked with [Illustris-3](#) simulation to provide a more comprehensive view of the relation between galaxy stellar mass and halo mass across cosmic times.

Project Radio Telescope ([Blog](#))

Mar'18 - Jul'21

— Dr. Prasanta Kumar Das, BITS Goa.

- Founded and coordinated a team towards building of a 5-m aperture Radio Telescope with primary motive to detect 21 cm H-lines
- Led the Computer Science Vertical as well as management of finance
- In collaboration with National Center for Radio Astrophysics (NCRA), Pune and Square Kilometer Array (SKA)

STUDY PROJECTS

Magnetohydrodynamic Simulations ([GitHub repo](#)) ([Report](#))

Jan'21 - May'21

— Dr. Kinjal Banerjee, BITS Goa.

FRW Metric, Inflation Theories and Cosmological Perturbation ([Reference](#))

Dec'18 - Oct'19

— Dr. Kinjal Banerjee, BITS Goa.

Using numerical analysis to understand Limit Cycle of Inflationary Universe

[\(Reference\)](#)

Jan'19 - May'19

— Dr. Chandradew Sharma, BITS Goa.

Study of Neutrino Interaction using Quantum Field Theory

(Report) (Certificate)

— Dr. Takuwa Morozumi, Hiroshima University, Japan

Jun'20 - Jan'21

ACHIEVEMENTS AND SCHOLARSHIPS

- National Graduate Physics Examination (NGPE) ([Certificate](#)) Jan'19
State Topper (Goa) in NGPE, 2019 held for undergrad students across India
- University Physics Competition (UPC) ([Certificate](#)) Nov'18
Won the Silver Medal in Nov 2018 for successfully writing a paper on [Optimal Compost Pile Sizes using Fractal Modelling of pores](#) under 48 hours
- Merit and Merit-cum-Need Scholarships Aug'17-Present
Awarded the BITS Pilani Merit Scholarship for Semester 1, Academic Year 2017-2018 and BITS Pilani Merit-cum-Need Scholarship for 3 Academic Years (2018-2021) for excellent academic performance (consistently in top 3% of batch of 850 students)
- Anchor and Coordinator, Vigyaan Samagam May'19-Oct'19
Organized and Hosted an Astronomy Quiz and conducted a [Radio Telescope Building Workshop](#) during, Vigyaan Samagam, Mumbai and Vigyaan Samagam, Bangalore, 2019
- Directors Funding- Project RT ([Certificate](#)) 2018-2020
Granted 50,000 INR from the Director of BITS Pilani, Goa Campus for Project RT
- Olympiads 2013-2014
Won Gold Medals in NSO (National Science Olympiad) (2013 & 2014), NCO (National Cyber Olympiad) (2014) & IMO (International Mathematics Olympiad)(2014) organized via the [SOF](#)

SERVICE AND TEACHING

- Coordinator, Physics Association ([Blog](#)) 2019-2021
- Secretary, SEDS (Students for Exploration and Development of Space) Celestia ([Website](#)) 2018-2019
- Instructor, [Astronomy, Astrophysics and Cosmology](#) course by Center for Technical Education 2018
- Teacher's Assistant for the course of Quantum Mechanics-I under Dr. Kinjal Bannerjee Jan'20-Jun'20
- Computer Science Lead, Project Radio Telescope 2019 - 2021

WORKSHOPS, SCHOOLS AND MOOCs

- Numerical Hydrodynamics, Perimeter Institute ([Course Page](#)) ([GitHub repo](#)) July'21
- Introduction to General Theory of Relativity, Coursera ([Certificate](#)) Aug'20
- North American Einstein Toolkit Workshop, Center for Computation & Technology, LSU ([GitHub repo](#)) ([Website](#)) Aug'20
- Basic Artificial Neural Networks in Python, Coursera ([Certificate](#)) Jul'20
- Introduction to Data Science in Python, Coursera ([Certificate](#)) Jul'20
- Foundations of Data Science: K-Means Clustering in Python, Coursera ([Certificate](#)) May'20
- Simulation and Modelling of Natural Processes, Coursera ([GitHub repo](#)) ([Certificate](#)) May'20
- Specialization in Mathematics for Machine Learning, Coursera Dec'19

SKILLS

Languages: Python, C/C++, SQL, Java, Verilog

Softwares & Tools: L^AT_EX, MATLAB, AREPO Code, Arduino

Skills: Data Analysis, Public Speaking, Teaching, Project Management and Planning, Writing and Editing