NIKHIL P. S. BISHT

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RESEARCH INTERESTS

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

EDUCATION

Florida State University (FSU), Tallahassee, FL   2022–Present
PhD Physics, Doctoral Candidate
Overall GPA: **3.54/4** – over 75 credits,
Thesis: *Simulating Molecular Cloud Collapse with ENZO*
Supervisor: Dr. David Collins

Birla Institute of Technology and Science (BITS), Pilani,India   2017–2022
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 (*1st Rank, Dept.of Physics*)
Thesis: *Radial Migration of Stars of Milky Way/M31 analogs in the TNG50 Simulation* *(Master's Thesis)*
Supervisor: Dr. Annalisa Pillepich, Max Planck Institute of Astronomy, Heidelberg

Indore Public School (IPS), Indore,India   2015-17
Higher Secondary Education, Overall score: **91.8 %**
Secondary Education, GPA **9.8/10**

RESEARCH PROJECTS

Simulating Molecular Cloud Collapse with ENZO   Nov'22 - Present
— Dr. David Collins, Florida State University, FL

- 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.

Machine Learning for Star Formation: Forecasting collapse of turbulent Molecular Clouds using 3D spatiotemporal models *(N. Bisht et al., in prep)*   Nov'24 - Present
— Dr. David Collins, Florida State University, FL

- Generated training dataset from multiple 128^3 MHD simulations of a collapsing molecular cloud over 1 free-fall time.
- Designed and implemented a 1.5M-parameter 3D UNet with attention + Conv-GRU modules 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.

Stellar Radial Migration in TNG50 Milky Way and M31-like analogs: diversity across and within galaxies (Master's Thesis) *(N. Bisht et al., in prep)*   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)   Jun'20 - Jan'21
— Dr. Takuya Morozumi, Hiroshima University, Japan

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(School Level)**   2013-2014
  Won Gold Medals in NSO (National Science Olympiad) (2013 & 2014), NCO (National Cyber Olympiad) (2014) & IMO (International Mathematics Olympiad)(2014)

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: LaTeX, MATLAB, AREPO Code, Arduino
Skills: Data Analysis, Public Speaking, Teaching, Project Management and Planning, Writing and Editing