

**Profile:** Ph.D. student in Computational Sciences at the University of Massachusetts Dartmouth. Broadly interested in General Relativity and High Performance Computing. Currently working as a Distinguished Doctoral Fellow in the Engineering and Applied Sciences program with a focus on modeling gravitational waves from extreme mass ratio black hole binaries using advanced numerical and mathematical techniques.

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**Personal Information :**

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**Research Experience :**

2021 - current (Ph.D. project)

**[EMRI modeling with spinning primary Black Hole using discontinuous Galerkin method \(arxiv:2307.01349\)](#)**

**Dr. Scott Field and Dr. Gaurav Khanna, UMass Dartmouth**

It is need of the hour to have a gravitational wave template bank for upcoming detectors. This project deals with one of the primary sources of the upcoming space borne detector LISA which are extreme mass ratio black hole binaries. I have written a very accurate Teukolsky solver code using discontinuous Galerkin method to model the waveform from EMRI system with a spinning primary.

2023 - current

**[Fast surrogate modeling of binary black holes in frequency domain](#)**

**Dr. Scott Field and Dr. Vijay Varma, UMass Dartmouth**

Surrogate modeling is an efficient technique to model compact astrophysical binary systems that could take a huge amount of CPU hours. We bypass that by a reduce order modeling of the system and then generate the time domain signals for detecting these astrophysical objects. I am working on directly modeling these systems in frequency domain and make it faster for paramter estimation.

June 27, 2020 - June 2021 (MS project)

**[Massless Scalar Waves in AdS Spacetime](#)**

**Dr. Rajesh Nayak, IISER Kolkata**

It has been shown in recent works that the non-asymptotic AdS spacetime eventually loses the curvature due to the formation of a black hole. The boundary conditions for this system are complicated, and hence very little work has been done on this topic computationally. I intend to explore the stability of the AdS spacetime when perturbed by gravitational waves. I used the scalar perturbations to study the solution of the massless scalar wave equation in this geometry. I worked on 4-dimensional spacetimes, but it can also be extended to N-dimensions.

- Aug. 2020 - Dec. 2020 **Independent study on Magnetohydrodynamics (MHD) and Fluid Dynamics**  
**Dr. Dibyendu Nandi, IISER Kolkata**  
The motivation for this independent study comes from General Relativistic Magnetohydrodynamic simulation of Neutron Stars. I aim to teach myself the concepts of Advection Equation and different types of flows in fluid systems. I am acquiring skills in MHD simulations so that I could learn the techniques of General Relativistic version of it.
- Dec. 2019 - March 2020 **Finesse (Frequency domain Interferometer Simulation Software) Workshop and Hackathon**  
**IUCAA Pune**  
Finesse is a sophisticated simulation package for modeling optics and laser interferometers. This interferometer modeling software was developed for the design of gravitational wave detectors, but is easy to use for students with simpler lab-based setups as well. It includes advanced features such as higher-order modes, quantum noise and radiation pressure effects. I used this tool to model aLIGO detector for the Hackathon.
- May 15 - July 15, 2019 **Reducing the flexing of the arms of LISA - a space based Gravitational Wave detector**  
**Dr. Rajesh Nayak, IISER Kolkata**  
Laser Interferometer Space Antenna (LISA) will be a spaced based gravitational wave detector with an array of three spacecrafts in heliocentric orbit. I developed a 3-body model to reduce the flexing in the arms of LISA due to the breathing modes. This project helped me develop computational skills, especially in using Python notebooks and theoretical concepts like perturbation theory and celestial dynamics. The project ended with me writing a Python code that could simulate the flexing in the arms of LISA over its observing run.
- Dec. 08 - Dec. 25, 2018 **Deriving Geodesic equations for different types of metrics**  
**Dr. Naresh Dadhich, IUCAA Pune**  
A short reading project of “**Curved Space, curved Time, and curved Space-Time in Schwarzschild geodetic geometry (arxiv:1812.03259)**”. I derived and calculated all the geodesic equations for different types of metrics associated with Schwarzschild geometry, considering space and time curvatures separately. The geodesic equations can then be used to calculate the deflections due to 1 solar mass object and it turned out to be exactly half of the “curved spacetime (1.75arcsec)” in “curved space” and “curved time” metrics.
- May 15 - July 15, 2018 **Reading project in Cosmology, General Relativity and Dark Matter**  
**Dr. Subhadip Mitra, IIIT Hyderabad**  
A reading project in General Relativity, Cosmology and Dark Matter. I studied General Relativity and Cosmology following textbooks by Scott Dodelson, Bernard F. Schutz and James Hartle. This project helped me gain the understanding of the basics of Tensor algebra and calculus, General Relativity, Cosmology, and Dark Matter

May 20 - July 20, 2017 **Quantum transport in mesoscopic system**  
**Dr. Sourin Das, IISER Kolkata**  
I developed a Python code using Kwant module which could model topological insulators in cubic and trapezoidal cubic geometry. This code was used to simulate quantum hall effect in the mesoscopic systems by attaching quantum gates to different sides of the cube, and measuring the resistance offered by each side.

## Education and Training:

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2021 - current **Ph.D., Computational Sciences**  
**University of Massachusetts Dartmouth (U.S.A)**  
**Department:-** Engineering and Applied Sciences  
**CGPA:-** 4.0/4.0

expected 2025 **Master of Science**  
**University of Massachusetts Dartmouth (U.S.A)**  
**Department:-** Data Science

2016 - 2021 **5 Year BS-MS Dual Degree**  
**Indian Institute of Science Education and Research, Kolkata(India)**  
**Department:-** Physics  
**CGPA:-** 8.4/10.0

## Academic Awards:

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2021 - current **Distinguished Doctoral Fellowship**, offered by the University of Massachusetts Dartmouth to pursue my research in black hole physics with Prof. Scott Field and Prof. Gaurav Khanna.

Aug. 2017 - June 2021 **KVPY** Scholarship, India (offered by the Department of Science and Technology, Government of India, to attract exceptionally highly motivated students for pursuing basic science courses and research career in science.)

Aug. 2016 - July 2017 **INSPIRE (Innovation in Science Pursuit for Inspired Research)** Fellowship (offered by the Department of Science & Technology to top 1% students to pursue a career in science)

2013 Awarded **Gold medal** for top performance in 10th standard.

**Other Achievements**

1. Selected for Super-30 in 2013 (a program which selects 30 talented candidates among thousands of applications each year to prepare them for **JEE**, an engineering entrance exam)
2. Qualified several Olympiads organized by Science Olympiad Foundation
3. Made an android application for Inquivesta, largest science fest of India.

## Personal Skills

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### Digital Skills

**Programming Languages**:- C, Julia, Python (modules: AstroPy, PyCBC, SciPy, NumPy, SymPy, pandas, Kwant, QuTip), R, SQL, jQuery, HTML, PHP, T<sub>E</sub>X

**Softwares** : - MATLAB, Mathematica, Origin, GnuPlot, ImageJ, L<sup>A</sup>T<sub>E</sub>X, Android Studio

### Languages

Hindi, English [TOEFL Score - Reading (21), Listening (25), Speaking (22), Writing (21)]

## Teaching

### Assitantships:

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1. Teaching Assistant for SS4101 (Space Astronomy) course offered by Center of Excellence in Space Sciences India (CESSI), IISER Kolkata to 4th year students in Autumn 2020.
2. Teaching Assistant for PH1201 (basic Electricity and Magnetism) course offered by Department of Physical Sciences, IISER Kolkata at freshman level in Spring 2020.

## Conferences and

### Workshops :

#### Talks/posters

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- Presented my poster at NAHOMCON/NENAD at Dartmouth College, USA
- Invited speaker at Infinity on a Gridshell workshop (virtual)
- Gave an invited talk at Astro-seminar, IISER Kolkata
- Gave an invited talk at MIT on September 11, 2023
- Gave an invited talk at Infinity on a Gridshell workshop held in Copenhagen, Denmark
- Presented my research project at 26<sup>th</sup> Capra meeting held in Copenhagen, Denmark
- Gave a talk on my research during my visit to zdAlbert Einstein Institute in Potsdam
- Presented my Ph.D. project at APS April meeting in Minneapolis.
- Presented a poster on my Ph.D. project at Sigma Xi research exhibit at UMass Dartmouth
- Gave an invited talk at University of Amsterdam on March 06, 2023.
- Gave an invited talk at Utrecht University on March 07, 2023.
- Presented my work at the Numerical Relativity Community Summer School at ICERM, Brown University in Providence, Rhode Island, USA
- Presented my work virtually at the Capra 25 held in Dublin, Ireland.
- Presented my Ph.D. project at APS April meeting in New York City.
- Presented my work over summer of 2020 at UMassD Physics colloquium (September 3, 2020)
- Gave an introductory talk on LISA and EMRI waveforms in Mini-Astro Workshop (October 6, 2020)

### Attended

- LISA Symposium, Dublin, Ireland
- North American High Order Methods Conference, Dartmouth College, USA
- Capra Meeting on Radiation Reaction in General Relativity, Singapore (virtual)
- APS April meeting in Sacramento, California, USA
- Capra Meeting on Radiation Reaction in General Relativity, Copenhagen, Denmark
- APS April meeting in Minneapolis
- SIAM CSE 23 at Amsterdam, Netherlands
- 25<sup>th</sup> Capra meeting
- APS April meeting in New York City.
- 24<sup>th</sup> Capra meeting
- Advances in Computational Relativity at ICERM, Brown University (September 9, 2020 - December 11, 2020)
- North American Einstein Toolkit Workshop 2020 (August 3-7, 2020), CCT, Louisiana State University (Virtual)
- TCAN on Binary Neutron Stars Workshop 2020 (July 6-10, 2020) CCRG, Rochester Institute of Technology (Virtual)
- 23rd Capra Meeting on Radiation Reaction in General Relativity June 22-26, 2020) University of Texas at Austin (Virtual)
- Cosmology Summer School 2020 (June 1-5, 2020), University of Michigan (Virtual)
- BHPToolkit Spring 2020 workshop (May 25-27, 2020), Astronomical Institute of the Czech Academy of Sciences (Virtual)
- Applications of Data Science in Astrophysics and Gravitational Wave Research (DSAP 2019) workshop held at IIIT Allahabad (November 1-3, 2019)
- GPU based High Performance Computing workshop at IISER Kolkata (October 14-15, 2019)
- Quantum Information and Quantum Technology (QIQT) 2019 at IISER Kolkata (June 13-July 27, 2019).

**References:**

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