

### Education

2014 - 2019 **Integrated Master of Science (Major: Physics, Minor: Mathematics),** [National Institute of Science Education and Research](#), Bhubaneswar, India, Current Grade: **9.31/10**

2013 - 2014 **Higher Secondary Examination (Standard 12th),** [Birla High School](#), Kolkata, India, Grade: **96.6 %** [\[see certificate\]](#)

2011 - 2012 **Secondary School Certificate (Standard 10th),** [St. Vincent's High and Technical School](#), Asansol, India, Grade: **95.47 %** [\[see certificate\]](#)

### Current Research Interests

- **Mathematical structures in QFT** - Understanding interesting mathematical structures encoded inside QFTs like the Amplituhedron in scattering amplitudes of  $N=4$  SYM, periods of Feynman motives, Hopf Algebra structure etc that have been recently shown to fit nicely into the broader unifying language of non-commutative geometry
- **Renormalization of open QFTs** - Most of the physical systems in nature are open, being in contact with its environment. One of my key interests is in developing a robust way to renormalize open non-unitary versions of important QFTs to model those systems.
- **Integrability structures in QM and QFT** - I am interested in understanding conditions of exact solvability of spectrum of operators living on a general Riemannian manifold.
- **Enumerative geometry problems related to the Moonshine programs and Mirror symmetry** - My interests lie in developing tools to map out the space of all possible moonshine connections between the sporadic groups and modular/mock-modular functions. Mirror symmetry, which connects ideas from symplectic geometry and complex geometry seems to hint at a picture of an underlying "quantum manifold" corresponding to some starting complex geometry. I am interested in understanding what the defining characteristics of such a "quantum manifold" could be and apply insights from that into problems in string theory compactifications.

### Academic Fellowships

May-July 2018 [S N Bhatt fellow](#) at International Center for Theoretical Sciences (ICTS), Bangalore working in strings group [\[see certificate\]](#)

May-July 2017 [Indian Academy of Sciences \(IAS\) Student Research fellow](#) at Delhi University working in particle physics group [\[see certificate\]](#)

2014 - 2019 [Innovation in Science Pursuit for Inspired Research \(INSPIRE\) fellow](#) at National Institute of Science Education and Research (NISER), Bhubaneswar throughout undergraduate program

2013 - 2014 Birla High School fellowship for covering full tuition fees during senior school

## Short-term Academic Visits

- September 2018 [Visiting student](#) at ICTS under strings group, hosted by *Dr. R Loganayagam*
- September 2016 [Visiting student](#) at Center for String Interactions, Harish Chandra Research Institute (HRI), India, hosted by *Dr. Anirban Basu*

## Completed Research Projects

- 2018 [\[see report\]](#) **Triangle loops in Open QFT** under *Dr. Loganayagam R., ICTS* - Exploring novel non-local divergences arising in non-unitary open QFTs, focussing mostly on the simple example of a single cut triangle diagram
- 2018 [\[see report\]](#) **Study of geometric phase of light** under *Dr. Ashok Mohapatra, NISER* - A simple hands-on experiment to measure and verify geometric phase of a light wave travelling through a collection of optical elements
- 2017 [\[see report\]](#) **Supersymmetric Quantum Mechanics** under *Prof. Debajyoti Choudhury, University of Delhi* - Understanding exactly-solvable quantum mechanical models using SUSY, looking closely at the interesting case of SUSY in higher dimensions (based on a Clifford algebra) and the consequent emergence of spin from the algebra
- 2017 [\[see report\]](#) [\[see poster\]](#) **Null Singularities in General Relativity** under *Dr. Yogesh Srivastava, NISER* - Classifying null singularities of various spacetime geometries using Penrose Limit approach (extracting the singularity profile from the plane wave limit of a given metric admitting null singularity)
- 2016 [\[see report\]](#) **Ideas in General Relativity** under *Dr. Yogesh Srivastava, NISER* - Reading project on textbook as well as special topics in General Relativity like Killing vectors, symmetric spaces, null singularities etc.
- 2016 [\[see report\]](#) **Quantum Harmonic Oscillator on a sphere** (presented as a computational physics project) - Modelling quark degrees of freedom of a pi-zero meson using a model of harmonic oscillator on a sphere
- 2015 [\[see report\]](#) **Aspects of Special Relativity** under *Prof. Soumitra Sengupta, IACS* - Reading project on textbook as well as special topics in Special Relativity like Lorentz group/algebra, relativistically covariant formulation of Maxwell's equations

## Ongoing Research Projects

- 2018 onwards **Renormalization of open QFTs** (Master's thesis under the guidance of *Dr. Loganayagam R.* and *Dr Sayantani Bhattacharya*) - Finding a scheme to absorb non-local divergences arising in non-unitary open QFTs and thereafter studying RG flow on it
- 2017 onwards **Computing BPS nos. for Calabi-Yau 3,4 and 5 folds using Bott's formula** under *Dr. Ritwik Mukherjee* - An interesting problem in enumerative geometry and mirror symmetry, we compute the no. of degree  $d$  rational curves (Gromov-Witten invariants) in complete intersection CY geometries using the famous residue formula of Bott.
- 2016 onwards **Exactly solvable models of quantum harmonic oscillator in symmetric Riemannian spaces** - In this work we construct some exactly solvable (integrable) models of harmonic oscillators in symmetric Riemannian spaces like sphere, projective spaces, hyperbolic spaces etc. This work underpins ideas from non-commutative geometry and explores deep connections between the quantized spectrum, its associated spectral zeta function and modular forms

## Papers/Preprints

- **Renormalization of Open Quantum Field Theory III: Non-local Divergences**, work in collaboration with *Dr. Loganayagam R. (ICTS)*, *Chandan Jana (ICTS)*, *Avinash (UC Davis)* and *Arnab Rudra (ICTP)* to be published soon
- **The quantum conch-shell: An exactly solvable model of harmonic oscillator on a sphere** to be published soon
- **Study of geometric phase using rotating wave-plates**, work in collaboration with *Dr. Ashok Mohapatra (NISER)* and *Tanmaya Mishra (NISER)* to be published soon

## Workshops and Conferences

- Conference [AdS/CFT at 20 and Beyond](#) from 21st May 2018 to 2nd June 2018 at ICTS (informal participation)
- Conference [J-Holomorphic Curves and Gromov-Witten Invariants](#) from 25th December 2017 to 4th January 2018 at ICTS
- Conference [National Strings Meet](#) from 5 to 10 December, 2017 at NISER
- Workshop [School and Workshop on Modular Forms and Black Holes](#) from January 5 to 14, 2017 at NISER
- Workshop [9th Asian Science Camp](#) from August 2 to 8, 2015 at Pathumthani, Thailand (was selected as a [see certificate](#) member of a **national delegation** of 20 students from India)
- Workshop [VIJYOSHI National Science Camp](#) from November 10 to 12, 2014 organized by Kishore Vaigyanik [see certificate](#) Protsahan Yojana (KVPY) in association with the INSPIRE program, Department of Science and Technology (DST) and Indian Institute of Science Education and Research (IISER)-Kolkata at Kolkata

## Talks and Presentations

- Presentation Presented a board talk on the topic **Spin Coherent State Path Integral: Continuum Approximation and Haldane Mapping** as a part of a project in Quantum Many Body Physics course  
[see notes](#)  
[see report](#)
- Presentation Presented the paper **An entanglement-based test of quantum gravity using two massive particles** by *C. Marletto* and *V. Vedral*(*arXiv: 1707.06036*) as a part of annual evaluation of Quantum Information and Quantum Computation course in October, 2017  
[see slides](#)  
[see report](#)
- Talk Delivered a popular talk at Science Activities Club (SAC), NISER with the title **The essence of physics: continuous vs discrete** in the month of January, 2017 on the juxtaposition of the continuous and the discrete in the classical and quantum worlds.
- Presentation Spoke on the topic **Neutrinoless Double Beta Decay** at NISER as a part of annual evaluation for the Nuclear and Particle physics course in November, 2016.  
[see slides](#)
- Talk Delivered a popular talk at Science Activities Club (SAC), NISER on the history and the scientific content of Einstein's Special and General Theory of Relativity, in the month of August, 2016 titled **From Space and Time to Spacetime: A journey towards understanding the true structure of our universe**
- Poster Gave a poster presentation on big bang and cosmic inflation at the **9th Asian Science Camp**, 2015
- Presentation in Thailand titled **The Universe Chronicle**  
[see poster](#)

Thesis Presentation Presented thesis work on **Renormalization of Open QFT** for mid-term thesis evaluation  
[\[see slides\]](#)  
[\[see report\]](#)

## Other Academic Achievements

- 2017 Finished in top **1%** at national level of [National Graduate Physics Examination](#), 2017
- 2015 Awarded [Certificate of Merit](#) for **outstanding academic performance**, in the 1st semester of Integrated MSc program at NISER
- 2014 Recipient of **gold medal** for **outstanding academic performance** in the school for Class XII CBSE Exam and other competitive exams
- Ranked [2<sup>nd</sup>](#) in the school science stream in the Class XII CBSE board exam
  - Qualified [Indian Statistical Institute \(ISI\) B. Math program](#) written exam ([see interview call](#))
  - Recipient of **INSPIRE scholarship** for being in the top **1%** of highest scorers in the Class XII Board Exam from the Department of Science and Technology, Government of India
  - Got selected for admission into [Indian Institute of Space Science and Technology \(IIST\)](#) with an all India rank of [491](#)
  - Ranked **438/150,000** in the West Bengal Joint Entrance Examinations
  - Ranked **173/50,000** in the **National Entrance Screening Test (NEST)** for admission into NISER
- 2012 Stood **1<sup>st</sup>** in school in the Class X ICSE board exam

## Standardized Tests

**General GRE** **324/340**, Quant: 164/170 (86 percentile), Verbal: 160/170 (86 percentile), AWA: 4/6 (59 percentile)

**Physics GRE** **900/990** (83 percentile)

**TOEFL** **111/120**, Reading: 28/30, Listening: 25/30, Speaking: 30/30, Writing: 28/30

## Computer Skills

**Mathematica** Avid user and enthusiast, have been an active [member](#) of Mathematica Stack Exchange site for over a year, contributions rated at top **6%** of the year. Developed a package to compute 1PI effective action for any polynomial potential of a scalar field theory.

**Maple** A beginner in Maple, got introduced to it while using the [HyperInt](#) package for performing Feynman loop integrals

**Java, C++** Fairly well-versed in most common as well as advanced algorithmic coding and coding constructs.

**JavaScript** Currently learning this language for developing interactive physics simulations. Used p5.js to visualize geometric phase as monochromatic light passes through a collection of optical elements (code available on [this](#) GitHub Repository)

**TeX/LaTeX** Have been using latex since my first year of undergraduate studies, feels more at home than word processors.

**Web Blogging** Started blogging since 2016 at [Peeping out of my submanifold](#). I publish both literary and academic pieces from time to time.

## Languages

English - Fluent

Bengali (mother tongue) - Fluent

Hindi - Fluent

## Extra-curricular Activities

- Have served as an **internal physics seminar** convener for the physics department at NISER for more than two years since 2016
- Organized and demonstrated fun experiments on Zeeman effect, Meissner effect, frustrated total internal reflection etc for hundreds of high school students on **National Science Day** at NISER for four years
- Served as an active member of the physics department's **Science Activities Club (SAC)** since my first year of undergraduate studies

## Relevant Coursework [\[view transcript\]](#)

### Core Physics Courses

- |                                     |  |
|-------------------------------------|--|
| - Mechanics and Thermodynamics      | - Statistical Mechanics                    |
| - Electricity, Magnetism and Optics | - Quantum Mechanics II                     |
| - Classical Mechanics I             | - Special Theory of Relativity             |
| - Mathematical Methods I            | - Nuclei and Particles                     |
| - Quantum Mechanics I               | - Electromagnetism II                      |
| - Electromagnetism I                | - Atoms, Molecules and Radiation           |
| - Mathematical Methods II           | - Introduction to Condensed Matter Physics |
| - Electronics                       | - Classical Mechanics II                   |

### Elective Physics Courses

- |                           |   |
|---------------------------|---|
| - General Relativity      | - Quantum Information and Quantum Computation |
| - Quantum Field Theory I  | - Introduction to Cosmology                   |
| - Quantum Field Theory II | - Quantum Many Body Physics                   |

### Core Mathematics Courses

- |                    |                          |
|--------------------|--------------------------|
| - Real Analysis I  | - Group Theory           |
| - Real Analysis II | - Probability Theory     |
| - Linear Algebra   | - Differential Equations |
| - Metric Spaces    |                          |

### Elective Mathematics Courses

- |                                   |   |
|-----------------------------------|---|
| - Geometry of Curves and Surfaces | - Topology (audited)                      |
| - Introduction to Manifolds       | - Calculus of Several Variables (audited) |
| - Statistics (audited)            |   |

## References

Dr. Loganayagam R.

Reader

ICTS, Bangalore

nayagam@icts.res.in

[\[Webpage\]](#)

Dr. Sayantani Bhattacharya

Reader-F

NISER, Bhubaneswar

sayanta@niser.ac.in

[\[Webpage\]](#)

Dr. Yogesh Kumar Srivastava

Reader-F

NISER, Bhubaneswar

yogeshs@niser.ac.in

[\[Webpage\]](#)

Prof. Bedangadas Mohanty

Professor

NISER, Bhubaneswar

bedanga@niser.ac.in

[\[Webpage\]](#)