# Ayush Singh

Geometry and Mathematical Physics,
Scuola Internazionale Superiore di Studi Avanzati, Trieste

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## EDUCATION

### NATIONAL INSTITUTE OF SCIENCE EDUCATION AND RESEARCH

Integrated Master's in Physics

Bhubaneswar, India

July 2017 – May 2022

- Final Grade Point Average: 9.09/10
- Relevant Coursework
  - Physics Electives: Particle Physics, General Relativity, Quantum Field Theory I & II, Phase Transitions & Critical Phenomena, Special Topics in Quantum Mechanics
  - Physics Core: Condensed Matter Physics, Statistical Mechanics, Atomic Physics, Nuclear Physics, Quantum Mechanics I & II, Classical Mechanics I & II, Special Relativity, Electromagnetism I & II, Mathematical Methods I & II
  - Mathematics: Representations of Linear Lie Groups, Differential Equations, Topology, Metric Spaces, Real Analysis, Probability, Linear Algebra, Group Theory
  - Computer Science: Theory of Computation, Discrete Structures in Computation, Algorithms and Data Structures

## PUBLICATIONS

- Ayush Singh, Colin Benjamin. "Magic angle twisted bilayer graphene as a highly efficient quantum Otto engine" (2021). Physical Review B **104**, 125445. arXiv:2103.13172.

## ACADEMIC EXPERIENCE

### MASTER'S THESIS ON QUANTUM FIELD THEORY AND GAUGE THEORY

National Institute of Science Education and Research

August 2021 – present

Bhubaneswar, India

- Project guide: Dr. Chethan N. Gowdigere, School of Physical Sciences, NISER
- Project outline: Spinor helicity, twistor variables, on-shell recursion and other modern methods of computing scattering amplitudes in gauge theory. Computation of beta functions and anomalous dimensions to one-loop level in abelian and nonabelian gauge theories.

### BACHELOR'S PROJECT ON CYCLIC QUANTUM HEAT ENGINES

National Institute of Science Education and Research

January – May 2020

Bhubaneswar, India

- Project guide: Dr. Colin Benjamin, School of Physical Sciences, NISER
- Project outline: Maxwell's demon and it's demonstration with Szilard engine, multi-particle quantum Szilard engine. Quantum analogues of standard thermodynamic cycles. Magnetically driven quantum heat engine based on a quantum dot, Magneto-strain driven quantum heat engine based on a graphene flake.
- This project eventually resulted in a publication discussing a proposal for a quantum heat engine based on magic-angle twisted bilayer graphene (see above).

### SUMMER READING PROJECT ON LIE GROUPS AND LIE ALGEBRAS

Indian Institute of Technology Bombay

May – July 2019

Mumbai, India

- Project guide: Dr. Sanjoy Pusti, Department of Mathematics, IIT Bombay
- Project outline: Metric topology, topological groups, matrix Lie groups, Lie algebras, Baker-Campbell formula, irreducible representations of SU(2), Clebsch-Gordan coefficients.

**SCHOLARSHIPS AND AWARDS**

- INSPIRE Fellowship sponsored by Department of Science and Technology (DST), Government of India during 2017–2022.
- *Outstanding Performance*, awarded for having the best grades among physics students in my batch, in semesters Spring 2019 and Spring 2020.

**POSITIONS OF RESPONSIBILITY**

### Coding Club
National Institute of Science Education and Research                                       Bhubaneswar, India

- Headed the club during Spring 2019 – Spring 2021.
- Led many student activities like a series of interactive sessions on machine learning, student seminars on quantum computation, and a hackathon on working with web APIs.
- Was involved with science outreach programs for high school students.

### Software Development Group
National Institute of Science Education and Research                                       Bhubaneswar, India

- Have been one of the founding members of the Software Development Group at NISER.
- Built web applications for the NISER community like a directory of things lost and found on campus and a community marketplace.

### NISERCast                                                                        nisercast.gitlab.io
National Institute of Science Education and Research                                       Bhubaneswar, India

- Led the production of NISERCast, a podcast in which professors at NISER talk to students about their work, life and what it's like being an academic.

**OTHER RELEVANT EXPERIENCE**

- I enjoy programming and am comfortable writing code to solve problems. I proficient in languages like C/C++, Python, Julia, Bash scripting. I have also dabbled in web development and machine learning.
- In Spring 2021, I tutored a group of first year students for introductory physics courses at NISER.