Ayush Singh

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RESEARCH INTERESTS

I am interested in pursuing research in the general area of quantum field theory. In particular, I am interested in the application of field theoretic techniques to fields like condensed matter and statistical physics, and also in the mathematical aspects of gauge theory and quantum field theory.

EDUCATION

National Institute of Science Education and Research — Bhubaneswar, India

Integrated Master's in Physics — July 2017 – May 2022

- Current Cumulative GPA: 9.05/10. My grades have been in the top two among physics students in my batch
- Relevant Coursework
  - Physics: Particle Physics, General Relativity, Phase Transitions & Critical Phenomena, Quantum Field Theory, Condensed Matter Physics, Statistical Mechanics, Atomic Physics, Computational Physics, Quantum Mechanics, Classical Mechanics, Special Relativity, Electromagnetism, Nuclear Physics
  - Mathematics: Representations of Linear Lie Groups, Differential Equations, Topology, Metric Spaces, Real Analysis, Linear Algebra, Group Theory
  - Computer Science: Theory of Computation, Algorithms and Data Structures, Discrete Structures in Computation

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 — August 2021 – present

National Institute of Science Education and Research — Bhubaneswar, India

- Project guide: Dr. Chethan N. Gowdigere, School of Physical Sciences, NISER
- Project outline: Functional quantization of scalar, spinor and gauge field theories. Computation of loop diagrams in quantum field theory. In particular, one-loop corrections and computation of beta functions for scalar field theories, quantum electrodynamics and nonabelian gauge theory.

Bachelor's Project on Cyclic Quantum Heat Engines — January – May 2020

National Institute of Science Education and Research — 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 — May – July 2019

Indian Institute of Technology Bombay — 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.

National Initiative on Undergraduate Science Camp — June 2018
Homi Bhabha Centre for Science Education, TIFR — Mumbai, India

- Attended a series of lectures on quantum mechanics, quantum computation, astronomy, and many-body physics; and completed a laboratory course based on experimental problem solving.

SCHOLARSHIPS AND AWARDS

- INSPIRE Fellowship sponsored by Department of Science and Technology (DST), Government of India.
- *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 to help with their physics coursework.

HOBBIES

- I like music and play guitar and bass occasionally.
- I like automating mundane tasks with code and building small electronics projects at home.