

Shihabul Haque

Integrated BS MS student in Physics (2020-2025), Indian Association for the Cultivation of Science, Kolkata (IACS)

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RESEARCH INTERESTS

I am primarily interested in theoretical high energy physics, with a specific focus on quantum field theory, elementary particle physics and cosmology. My current background includes hands-on experience in some aspects of astro-particle physics, including BSM physics. In the future, I would like to get into more fundamental aspects of the field while continuing to study phenomenological models and their consequences and other aspects of astrophysics and cosmology.

EDUCATION

1. Indian Association for the Cultivation of Science, Kolkata, India October 2020 – August 2025
Integrated Bachelor's - Master's in Physics **CGPA: 9.56/10.00** (as of semester 7)

Relevant coursework: Lagrangian & Hamiltonian formalisms, Quantum Mechanics, Statistical Mechanics, Classical and Quantum field theory, General Relativity, Statistical field theory.

2. South Point High School, Kolkata, India April 2018 – March 2020
CBSE XII **Final percentage: 95%** (98 in physics, 97 in maths)

3. South Point High School, Kolkata, India April 2016 – March 2018
CBSE X **Final percentage: 96.6%** (96 in science, 95 in maths)

SKILLS

• **Programming languages:** Julia (advanced), Python (basic), C/C++ (basic) • **Software:** L^AT_EX, Mathematica

PREVIOUS EXPERIENCE

School of Physical Sciences, Indian Association for the Cultivation of Science 2 years BS - MS project
Supervisor: Sourov Roy, Senior Professor **August 2023 – Present**

- I started working on my BS MS project in August 2023 on axions, by exploring some of the existing literature in the context of axion-photon oscillations. Specifically, I worked through some seminal papers using both analytical and computational techniques to replicate published results (for example, *Raffelt et. al. (1988)*, *Grossman et. al. (2002)*, *Masaki et. al. (2017)*).
- My first semester was focused on astrophysical consequences of ALP/photon oscillations, so I plan to look into the particle physics aspects further on. Along with this, I plan to investigate the current ALP/photon oscillation models incorporating some ideas implemented in other areas/models and explore similar mixing phenomenon in the context of gravitons and photons as well.

Department of Physics, Chennai Mathematical Institute, Chennai, India Summer project
Supervisor: H. S. Mani, Adjunct Professor **June 2023 – July 2023**

- My summer project was based on the idea of “weak” measurements. I looked at projective measurements, weak values and how our conceptual understanding of the idea evolved over time, initially working on a straightforward example - calculating weak values for a spin 1 system.
- Subsequently, I looked into the relation weak measurement and interference, replicating the results in *Sokolovski et. al. (2018)* in general settings and explicitly calculating the weak values in a few simple quantum systems. A brief report on some parts of the project can be accessed [here](https://drive.google.com/file/d/1W1Zh5amoQ10JHnZ_v5uKxxS0h-qucD1/view?usp=sharing) (url: https://drive.google.com/file/d/1W1Zh5amoQ10JHnZ_v5uKxxS0h-qucD1/view?usp=sharing).

School of Physical Sciences, Indian Association for the Cultivation of Science Long term project
Supervisor: Jayanta K. Bhattacharjee, Emeritus Professor **December 2021 – January 2024**

- I learnt quite a bit about nonlinear systems and resonant behavior under Prof. Jayanta Bhattacharjee (now at IIT, Kanpur). Initially, I learnt about different approximating techniques, perturbative techniques, dealing with diverging quantities and applied these ideas to physical systems. All this came in useful for more complex systems later.

- For my first major project, I worked on parametric resonances in a double spring pendulum, leading to some interesting and new results. I presented our work at **NODYCON, 2023**, in Rome (I personally presented online). Specifically, we derived multiple parametric resonance conditions for the system and looked into the numerical solutions of the same at those conditions along with a brief foray into the chaotic aspects of the same.
- I also worked on the idea of resonance in a forced oscillator, specifically in the context of its finite response. For smaller drives, we characterised two drive-dependent scaling laws and showed that the finiteness of the resonant response can be attributed to a destructive interference like effect. At larger drive values, we numerically showed that the oscillator undergoes a first order transition. The crux of this work is summarized in an arXiv preprint. At present, this work is under further revisions with plans to submit to an appropriate peer-reviewed journal soon.

Department of Physics, Rajabazar Science College, Kolkata, India

Supervisor: *Amitava Raychaudhuri, Professor Emeritus*

Summer project

May 2022 – August 2022

- A brief summer project learning about neutrinos starting from the covariant formulation of the Dirac equation and looking into SU(2), spinors and their transformation properties, and neutrino mass models.

PRESENTATIONS, PUBLICATIONS & PREPRINTS

Presentations:

- Haque, S., Sasmal, N. & Bhattacharjee, J. K. (2023). “*An extensible double pendulum and multiple parametric resonances.*” NODYCON 2023, Rome (abstract available [here](#) or url: https://nodycon.org/2023/papers/192/abstract_submissions/621/view_abstract)

Publications/Preprints:

- Haque, S., & Bhattacharjee, J. K. (2024). “*Interference aided finite resonant response in an undamped forced oscillator.*” arXiv preprint ([arXiv:2305.04125](#)).
- Haque, S., Sasmal, N. & Bhattacharjee, J. K. (2024). “*An extensible double pendulum and multiple parametric resonances.*” NODYCON 2023 Proceedings (in press - selected after peer review).

AWARDS

KVPY 2019 SX Fellow

2020 – 2025

I am primarily funded by the KVPY fellowship provided by the DST, Government of India, for selected students pursuing basic sciences. I am not eligible for other state-sponsored scholarships for this duration (but not private ones - applicable only within India).

OTHER RELEVANT EXPERIENCES

- Completed an astronomy course organized by the **Breakthrough Science Society, Kerala Chapter**.
- Zonal Toppers (Kolkata), **Mimamsa 2022**, a national level open book team-based science competition.
- Ranked 61 worldwide in Open Category (O) in the Physics Brawl Online, an international physics team competition.