

SHIHABUL HAQUE

PhD student, Theoretical Particle Physics Group (TPP)
International School for Advanced Studies (SISSA) (Expected start: Oct. 2025)
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RESEARCH INTERESTS

I am interested in **theoretical high energy physics**, specifically **quantum field theory**, **elementary particle physics** and **cosmology**. I am interested in BSM phenomenology - specific topics where I have hands-on experience include **ALPs**, **Higgs sector**, **electroweak symmetry breaking** and **dark matter**. In the future, I would like to study phenomenological models and their consequences with an emphasis on model-building.

EDUCATION

1. Indian Association for the Cultivation of Science, Kolkata, India August 2020 – July 2025
Integrated Bachelor's - Master's in Science, Physics major - **Gold Medallist** **CGPA: 9.64/10.00**

Relevant coursework: Quantum Field Theory, Statistical Field Theory, General Relativity, Particle Physics.

2. South Point High School, Kolkata, India
CBSE XII (2020): **95%**, CBSE X (2018): **96.6%**

SKILLS

• **Programming languages:** Julia, Python • **Software:** \LaTeX , Mathematica

PREVIOUS EXPERIENCE

ALP/photon mixing and related phenomena in astrophysical scenarios August 2023 – July 2025
School of Physical Sciences, Indian Association for the Cultivation of Science 2 years BS - MS project
Supervisor: Sourov Roy, Senior Professor; Soumitra SenGupta, Senior Professor (co-supervised RS model work)

- Investigated astrophysical consequences of ALP/photon mixing, including polarisation effects via Stokes parameter estimation from numerical solutions of mixing equations. Extended mixing framework to include graviton/photon scenarios and explored potential observational signatures.
- Used observational bounds on ALP-photon coupling to constrain Randall-Sundrum (RS) models, yielding implications for its solution to the gauge hierarchy issue.
- Extended standard arguments for axion echoes to multi-ALP scenarios, deriving a theoretical model-independent framework for estimating such echo signals.

Collider and GW signals of electroweak phase transition in the THDM July 2024 – August 2024
Department of Physics, Osaka University, Japan International Summer Program (ISP) 2024
Supervisor: Shinya Kanemura, Senior Professor

- Studied electroweak phase transitions in the Two Higgs Doublet Model (THDM) with relevance to baryogenesis.
- Analyzed effective potentials and loop corrections to Higgs self-coupling as collider probes of strong first-order phase transitions and gravitational wave signals from bubble collisions during the phase transition epoch as cosmological probes of the same.
- Final report available [here](#).

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

- Analyzed parametric resonances in a double spring pendulum, presenting findings at **NODYCON 2023**.
- Investigated finite response of the resonant forced oscillator: identified two drive-dependent scaling laws and demonstrated destructive interference-like mechanism, responsible for the finiteness of the amplitude. Showed numerically that high-drive regimes yield a first-order transition. Published in *J. Phys. A: Math. Theor.*

PRESENTATIONS, PUBLICATIONS & PREPRINTS

PRESENTATIONS:

- "Testing the electroweak phase transition with future collider experiments and gravitational wave observations." ISP 2024, Osaka University (non-technical due to audience background; slides available [here](#))
- Haque, S.**, Sasmal, N. & Bhattacharjee, J. K. (2023). "An extensible double pendulum and multiple parametric resonances." NODYCON 2023, Rome

PUBLICATIONS/PREPRINTS:

- **Haque, S.,** & Roy, S. (2025). "Multiple ALPs and enhanced echoes". [arxiv:2507.16555 \[hep-ph\]](#) (under review)
- **Haque, S.,** Roy, S., & SenGupta, S. (2024). "Translating current ALP photon coupling strength bounds to the Randall-Sundrum model". [arxiv:2411.08396 \[hep-ph\]](#) (under review)
- **Haque, S.,** & Bhattacharjee, J. K. (2024). "Interference aided finite resonant response in an undamped forced oscillator". *J. Phys. A: Math. Theor.* **57** 325701 ([10.1088/1751-8121/ad6412](#))
- **Haque, S.,** Sasmal, N. & Bhattacharjee, J. K. (2024). "An extensible double pendulum and multiple parametric resonances.", *Advances in Nonlinear Dynamics*, Volume I, NODYCON Conference Proceedings Series. ([10.1007/978-3-031-50631-4_12](#))

AWARDS

Scholarship for Super Short Term Study, Osaka University

July 2024 – August 2024

I was nominated for and selected as a recipient of the competitive *Scholarship for Super Short Term Study* at the Graduate School of Science, Osaka University, which supported my stay in Japan for the duration of the ISP, 2024.

KVPY 2019 (SX) Fellow

2020 – 2025

I was funded by the KVPY fellowship provided by the Department of Science and Technology, Government of India, for selected students pursuing basic sciences throughout my BS-MS program.

ACADEMIC TRAINING

Introductory School on Conformal Field Theory (ISCFT)

August 2025

- Indian Association for the Cultivation of Science | Kolkata, India

ADDITIONAL ACADEMIC EXPERIENCES

- Astronomy course (Breakthrough Science Society, Kerala Chapter); Zonal Toppers, Mimamsa 2022; Rank 61 worldwide, Physics Brawl Online 2022 (Open Category)

Last updated: August 5, 2025