Soumyajit Datta

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Education

2020 - 2025	**BS-MS**, *Indian Institute of Science Education and Research*, Kolkata, CGPA – 8.45/10, **Major** : Physical Sciences, **Minor** : Mathematics
2020	**Higher Secondary**, *Birbhum Zilla School* Class 12 – 97.8 %

Research Interest

Effective field theories, Collider Phenomenology, Neutrino Physics, Dark Matter, Baryogenesis, Early Universe Cosmology, Machine Learning techniques in particle physics

Master's Thesis

Sept 2024 – April 2025

Lepton Number Violation in the Standard Model Effective Field Theory

Supervisor: Prof. Subhaditya Bhattacharya, IIT Guwahati

I explored how lepton number violation arises in SMEFT and how it serves as a probe of BSM physics. Particularly, I studied the lepton number violating process $\mu^+\mu^+ \to W^+W^+/W^+qq'$ at the same-sign muon collider μTRISTAN, using the final-state signature comprising two fat jets. This process is sensitive to 8 distinct dimension 7 SMEFT operators. We determined the maximal sensitivity to these operators and compared our results with existing LHC constraints and future FCC projections. (Thesis)

Publications

[1] S. Bhattacharya, **S. Datta** and A. Sarkar, *Probing $\Delta L = 2$ lepton number violating SMEFT operators at the same-sign muon collider*, 2505.20936.

Software Skills

Languages	Python, Matlab, Mathematica
Tools	LaTeX, Numpy, Pandas, Uproot, Matplotlib, PyTorch, XGBooster
Collider tools	FeynRules, MadGraph, MadAnalysis
ML tools	Boosted Decision Tree, Deep Neural Network, Graph Neural Network

Projects

Sept 2025 –

SMEFT interference to probe top quark Yukawa coupling at future lepton colliders

Collaborator: Abhik Sarkar, IIT Guwahati

We are working to determine the sensitivity of ILC to the top Yukawa coupling modifier, κ_t, through the $t\bar{t}h$ production process.

April 2025 –	**Optimal sensitivity of anomalous HVV couplings in $\nu\nu H$ production process at future e^+e^- collider**
	Collaborator: Dr. Amir Subba, IIT Guwahati
	We are working to determine the sensitivity of anomalous HVV couplings in SMEFT using the Optimal Observable Technique (OOT).
May 2024	**Applications of Heat-Kernel Method**
	Supervisor: Prof. Joydeep Chakrabortty, IIT Kanpur
	I studied the book 'Heat Kernel Method and its Applications' by I. Avramidi and learned the ingredients of heat kernel method and its applications in different systems. (Report)
May 2023	**Electroweak Interactions and Effective Field Theory**
	Supervisor: Prof. Subhaditya Bhattacharya, IIT Guwahati
	I studied the standard model electroweak theory and calculated the Fermi constant (G_F^2) in terms of the full theory. I also studied a bit of effective field theory and its application to dark matter.

Scholarship

2021 – 2025	**Inspire Scholarship** awarded by Department of Science and Technology, Govt. of India.

Schools and Workshops

July 2025	**Machine Learning for High Energy Physics,** *Organized by IISER Kolkata* [Link]
	I learned the statistical methods and machine learning techniques used in high energy physics. Specifically, I learned the use of CNN, GNN, GAN in jet physics (jet classification, jet substructure finding), and use of Normalization Flow in BSM physics searches.
Dec 2024	**Standard Model Effective Field Theories and Applications to Higgs, Neutrinos and Dark Matter,** *Organized by IIT Guwahati* [Link]
	Instructors: Prof. Jose Wudka (UC, Riverside) and Prof. Subhaditya Bhattacharya
	We learned the formal theoretical aspects of EFT, particularly SMEFT, and its applications in Higgs, neutrino, and dark matter physics.

Other Projects

Fall 2024	**The Physics of Flocking ,** *Independent Study*
	I studied how flocking occurs, despite the Mermin-Wagner-Hohenberg theorem preventing it in two or lower dimensions. (Presentations & Report)
Spring 2023	**Path Integrals in Quantum Mechanics,** *Term Paper*
	We studied the path integral formulation of quantum mechanics and derived the Fermi Golden rule using this formalism. (Report, Presentation)

Teaching Experience

Spring 2024	Teaching Assistant of the course PH1201: Electricity and Magnetism (Certificate)
Fall 2023	Teaching Assistant of the course CS1101: Introduction to Computer Programming (Certificate)

Relevant Courses

- High Energy Physics
- Quantum Field Theory I
- Quantum Field Theory II
- General Relativity & Cosmology
- Advanced Quantum Mechanics
- Classical Electrodynamics