

CHAITANYA PARANJAPÉ

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Education

Indian Institute of Technology (ISM) Dhanbad

Bachelor of Technology in Engineering Physics, Cum. GPA: 9.49/10.0

Dhanbad, India

Expected May 2022

Relevant Coursework

- Computer Programming * Methods of Applied Mathematics * Numerical and Statistical Methods * Waves & Acoustics * Electronics & Optical communication * Applied Optics * Classical Mechanics * Mathematical Physics * Quantum Mechanics * Electrodynamics * Solid state physics * Statistical mechanics * Low temperature physics & Superconductivity * Astrophysics & Cosmology
- Precision Phenomenology at Colliders by Prof. Dr. Gudrun Heinrich, KIT : My solutions to exercises

Online Courses

- Special theory of relativity (Stanford University, Coursera) * Data Analysis with Python (IBM, Coursera) * QM & Mastering QM (MIT 8.04x-8.05x, EdX) * Particle Physics (University of Geneva, Coursera) * Quantum Field Theory (IIT Madras, NPTEL)

Academic Achievements

- Mitacs Globalink Research Scholar 2021
- DAAD WISE Research Scholar 2021
- Rank 1 Undergraduate student at Department of Physics, IIT Dhanbad
- All India Rank of 7428 in JEE(advanced) 2018

Publications & Technical reports

- [1] **C. Paranjape**, D. Stolarski, and Y. Wu, "Analysis of Higgs production through vector boson fusion at the LHC," 2021. [arXiv:2203.05729](#).
- [2] **C. Paranjape** and G. Heinrich, "Higgs plus three-gluon amplitude at one loop with pySecDec," 2021. (Conference proceeding submitted to IOPscience JPCS).
- [3] **C. Paranjape** and T. Ahmed, "Integration by parts identities and Scattering amplitudes," 2020.

Undergraduate Thesis

- [4] **C. Paranjape**, D. Stolarski, and B. Panda, "Unifying the dark QCD with Standard Model," 2021 (Work in progress).

Research experience

Theoretical particle physics group, Carleton University

Ottawa, Canada

Mitacs Globalink Research Intern (GRI 2021) under Dr. Daniel Stolarski

March 2021–Sept 2021

- Aim to probe the Higgs couplings to vector bosons (κ_W, κ_Z) with the analysis of $pp \rightarrow qqH\gamma$ through vector boson fusion.
- Designed cuts based upon the vector boson fusion topology to suppress the large background contribution (\sim signal yield $\times 10^4$) in $H \rightarrow b\bar{b}$ decay mode.
- Designed a custom FastJet+Delphes simulation framework to employ modified boosted Higgs search algorithms, finally controlling the background to (\sim signal yield $\times 4$)
- Proposed to conclusively rule out the $(\kappa_W, \kappa_Z) = \pm(1, -1)$ point with more than 95 % CL at the HL-LHC with our analysis strategy. [1]

Institute for Theoretical Physics, Karlsruhe Institute of Technology

Karlsruhe, Germany

DAAD Wise Research Scholar 2021 under Prof. Dr. Gudrun Heinrich

June 2021–July 2021

- Applying the feature of numerical evaluation of weighted sums of integrals onto an intricate 1-loop example as a basis for multi-loop calculations [2].
- Numerically evaluating the 1-loop amplitude for $gg \rightarrow gH$ by expressing the form factors as a weighted sum of Master integrals. Identified the symmetry between form factors to calculate helicity amplitudes.
- Calculated the Master integrals with expansion by regions method in the Heavy Top Limit by expanding in power series of $(1/m_t^2)$.
- Performed an error analysis to test the validity of error bounds depending on the scale of the invariants and confirming a relative precision of at least 10^{-4} on the weighted sum.
- This example can serve as a concrete basis to extend the proposed techniques to advancement of multi-loop calculations.

Institute of Nuclear Physics Polish Academy of Sciences,

Particle Physics Summer Student Intern (PPSS-2020) under Dr. hab. Andrzej Siodmok

Cracow, Poland

July 2020–August 2020

- Aim to devise a machine learning approach for Hadronization, expanding upon the current cluster model.
- Designed custom Analysis handler with Herwig to prepare data-sets for particular cluster decays.
- Training and testing effectiveness of various machine learning models with Python libraries like Keras and Tensorflow.
- Devised a Generative Adversarial Network based on the idea of 'Replication', to successfully replicate the cluster decays into pions.

GitHub Code

GitHub Code

Study project in precision calculations

under Dr. Taushif Ahmed

Sept 2020–Dec 2020

- Studied the framework of QFT and application of Integration by parts identities for evaluation of loop amplitudes.
- Explored the mathematical structure of IBP identities through the standard topology of loop integrals like 1-loop bubble & tadpole, 2-loop massless self energy diagram [3].
- Employed the use of LiteRed to study the IBP Reduction process for advanced examples and investigated strategies for automation at multi-loop level.

Conferences

Advanced Computing and Analysis Techniques in Physics Research - ACAT 2021

December 2021

Virtual and IBS Science Culture Center, Daejeon, South Korea

Presentation slides: PDF

- Presented the application of latest pysecdec features based on my work [2]. *Contribution*

Canadian Undergraduate Physics Conference - CUPC 2021

November 2021

Ryerson university, Toronto, Canada

Presentation slides: PDF

- Presented the results of our analysis for Higgs production through VBF-VH channel [1].

Summer students project presentations - Carleton 2021

Septemeber 2021

Carleton university, Ottawa, Canada

Presentation slides: PDF

- Presented a novel analysis strategy for Higgs production through VBF-VH channel [1].

Particle physics summer student presentations - PPSS 2020

July 2020

Institute of Nuclear Physics Polish Academy of Sciences, Cracow, Poland

Presentation slides: PDF

- Presented application of GAN model for hadronization of pions based on my work as a summer student.

Technical Skills

*MC event generation: MadGraph5 * Pythia * Delphes * Herwig*

*Jet analysis: FastJet * Delphes*

*Amplitude calculations: pySecDec * LiteRed * FeynCalc*

*BSM model building: FeynRules * LieART*

*Environments/Tools: Linux * Git/Github * ROOT * Python * C/C++ * Mathematica * L^AT_EX*

Independent study

- Introduction to Quantum Mechanics (Complete) *D.J. Griffiths*
- Introduction to Elementary particles (Complete) *D.J. Griffiths*
- From Special Relativity to Feynman Diagrams (Complete) *R. D'Auria & M. Trigiante*
- An introduction to Quantum Field Theory (→ Chapter 6) *M. Peskin & D. Schroeder*
- Lie algebras in particle physics (→ Chapter 7) *H. Georgi*

Research Interests

- Development of mathematical techniques for theoretical particle physics research, $\mathcal{N} = 4$ SYM, String theory
- QCD and Nuclear theory research : perturbative QCD, non-perturbative QCD, hadron structure with Lattice QCD
- Advancement of multi-loop calculations for precision phenomenology
- Application of Effective field theories for Quark gluon plasma, SM extensions \sim Higgs sector & dark matter

Service & Mentoring

- Organizing seminars in the Department of Physics to provide exposure to UG students in various areas of physics research. Mentoring junior UG students for physics research.
- Part time physics and mathematics tutor at the Wakade's classes (Mumbai) for high school students.
- Indian National Service Scheme (NSS) Cadet actively taking part in community service activities.
- Directing short films, video editing and cinematography as a senior member of IIT Dhanbad's official cinematography club - Lights Camera ISM.
- Working with robotic projects like obstacle avoider or hand gesture bots to participate in technical competitions.