CHAITANYA PARANJAPE

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Education

Indian Institute of Technology (ISM) Dhanbad **Dhanbad, India**
Bachelor of Technology in Engineering Physics, Cum. GPA: 9.52/10.0 *Gold Medalist, 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 ∗ Nanotechnology ∗ Computational Physics
- 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) ∗ Quantum mechanics & Quantum computation (By Prof. U. Vazirani, EdX)

Academic Achievements

- Mitacs Globalink Research Scholar 2021
- DAAD WISE Research Scholar 2021
- GRE Physics subject Test score : 970/990 with 93 percentile
- Gold Medalist of graduating batch of B.Tech Engineering Physics (2022) at IIT (ISM) Dhanbad
- All India Rank of 7428 in JEE (Advanced) 2018 examination.

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.

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 $pp \to qqHZ$ 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 $H \to b\bar{b}$ decay mode.
- Designed a custom FastJet+Delphes simulation framework to employ modified boosted Higgs search algortihms, 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*

- Appliying the feature of numerical evaluation of weighted sums of integrals onto an intricate 1-loop example as a basis for multi-loop calculations [2]. **GitHub Code**
- Numerically evaluating the 1-loop amplitude for $gg \to gH$ by expressing the form factors as a weighted sum of Master integrals.
- 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^{-7} and error percentage of 0.00179% 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, **Cracow, Poland**
Particle Physics Summer Student Intern (PPSS-2020) under ***Dr. hab. Andrzej Siodmok*** *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. **GitHub Code**
- Training and testing effectiveness of various machine learning models with Python libraries like Keras and Tesnsorflow. **GitHub Code**
- Devised a Generative Adversarial Network based on the idea of 'Replication', to successfully replicate the cluster decays into pions.

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 identitites 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.

Academic Conferences & Talks

EF04 Topical Group Community Meeting for Snowmass 2021 **February 2022**
(EF04) EW Precision Physics and constraining new physics *Presentation slides: PDF*

- Presenting the results of VBF-ZH analysis at the LHC. [1].

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].

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.

Outreach Talks

Let's Talk Research **May 2022**
IIT (ISM) Dhanbad, India *Shared Resources: GitHub*

- The aim of the "Let's Talk Research" session was to encourage the students to pursue research on any topic of their interest. We talked about multiple fields of study and discussed how one could start exploring their interest. *View the complete recording here.*

Research Talks Series **May 2022**
IIT (ISM) Dhanbad, India *Playlist of Talks: YouTube*

- Collaborating with student-run newsletter of IIT (ISM) Dhanbad, We interviewed some final-year undergraduate students of the batch 2022, who shared their exact experiences of working on research projects, publishing in journals and presenting at a Conference. *My personal Talk*

Technical Skills

Monte Carlo simulations: MadGraph5 ∗ Pythia ∗ Delphes ∗ Herwig
Analysis frameworks: FastJet ∗ Delphes
Computations in Particle Physics: pySecDec ∗ LiteRed ∗ FeynCalc ∗ LieART
Environments/Tools: Linux ∗ Git/Github ∗ ROOT ∗ Python ∗ C/C++ ∗ Mathematica ∗ LaTeX

Service, Mentoring & Outreach talks

- Part-time Calculus teacher at the Wakade's classes (Mumbai) for senior high school students.
- 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.
- 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.
- Indian National Service Scheme (NSS) Cadet actively taking part in community service activities.