CHAITANYA PARANJAPE

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Education

Indian Institute of Technology (ISM) Dhanbad   **Dhanbad, India**
Bachelor of Technology in Engineering Physics, Cum. GPA: 9.49/10.0   *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. (e-print work in progress).

[2] **C. Paranjape** and G. Heinrich, "Higgs plus three-gluon amplitude at one loop with pySecDec," 2021. (Conference
     proceeding to be 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 $pp \rightarrow qqHZ$ 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 $H \rightarrow b\bar{b}$ 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 (κ_W, κ_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 $gg \rightarrow gH$ by expressing the form factors as a weighted sum of Master inte-
  grals.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, **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.

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 ∗ LaTeX

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 ∼ 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.