

First Semester Report

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Introduction

This semester was primarily focused on foundational preparation in order to successfully undertake research in the coming semesters. Although research output was minimal, the semester was focused on coursework, developing computational skills and studying concepts essential for my future research.

Summary of Activities

Coursework

I took the QCD course which was directly relevant to my area of study and invaluable for understanding the research my team is conducting. I also attended the lectures of the masters level course QFT II. While this did not contribute to my credits it served as a useful refresher.

Conferences

Attended the High Precision for Hard Procedures Conference in Torino, Italy. There, I saw many talks closely related to my area of study, and met several colleagues working on complementary topics with whom I plan to collaborate with in the future.

Preparation for future research

I have conducted literature reviews of several topics I believe will be essential in my research. Namely, the spinor-helicity formalism and its generalisation to massive fermions, using the papers [1] and [2]. I studied Britto-Cachazo-Feng-Witten recursion from the papers [3] and [1]. I also spent time developing computational skills. I learned how to use Mathematica for general calculations and, more specifically, FeynCalc for calculating amplitudes and cross sections. I was introduced to numerical calculations using FORTRAN-90. I also attended

two talks given online by Giuseppe Bevilacqua on the Local Analytic Subtraction Scheme this will also be an essential part of the research i will be doing. I applied to attend the Computer Algebra and Particle Physics (CAPP-2025) school in Hamburg, Germany in March. This will be very important for developing computational skills for future work.

Research carried out

I assisted in writing the code to calculate the matrix element squared of the process $e^+e^- \rightarrow t\bar{t}g$ with FORTRAN 90 and Mathematica. And I am currently assisting with the code writing for the process $q\bar{q} \rightarrow t\bar{t}g$. As part of this I calculated, by hand, the colour factors for the matrix element squared to resolve conflicting conventions with the value of T_r in the code.

Plans for Next Semester

I plan to run Monte-Carlo integration for NLO gluon-induced DIS massive di-quark production. I also will attend the CAPP-2025 school to enhance my understanding of and skills in computational methods.

Conclusion

This first semester has been an essential period for building skills and gaining the necessary knowledge for succeeding in my PhD program. Although direct research may have been limited, the foundation laid has been fundamental for successfully carrying out research in the coming semesters.

References

- [1] John M. Campbell and R. Keith Ellis. Top tree amplitudes for higher order calculations. 2023.
- [2] Alexander Ochrirov. Helicity amplitudes for qcd with massive quarks. 2018.
- [3] Michael E. Peskin. Simplifying multi-jet qcd computation. 2011.