Andrea Ghira

First Year PhD Report

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Research Activity (under supervision of S.Marzani and G.Ridolfi)

My research activity is focused on quantum field theory with particular attention to high energy physics calculations in the context of LHC phenomenology.
I spent my first months learning the necessary tools to start my research activity with particular attention to SCET (Soft Collinear Effective Theory) and the effective field theory in general. After the month of January, during which I attended the GGI phd school, I started a project in collaboration with the Master student Daniele Gaggero regarding soft gluon resummation in QCD.
We focused on the technical aspect of the non commutativity of soft (gluon radiation that becomes soft) and massless (the mass of the quark is considered far smaller than the hard scale of the process) limits in processes involving heavy flavours.

Courses and Exams

I attended the following courses:
- Statistical Field Theory (A. Amoretti, 6CFU),
- Non-Abelian Gauge Theory (N. Maggiore, 3CFU),
- AdS/CFT (A. Amoretti, 3CFU).

I passed the following exam:
- Statistical Field Theory (A. Amoretti, 6CFU).

Schools and Conferences

I attended the following PhD schools and conferences:
- Christmas Meeting,
  Università degli Studi di Milano, Milan, 21/12/2021-23/12/2021,
- GGI PhD School (Lectures on theory of foundamental interactions),
  Online lectures, 09/01/2022-28/01/2022,
- CTEQ PhD School (Lectures on QCD phenomenology),
  University of Pittsburgh, Pittsburgh, 06/07/2022-16/07/2022,
- **Invited Speaker at LFC22 Workshop** (Linear and Future Collider 2022),
  ECT*, Trento, 29/08/2022-02/09/2022,
- Workshop for Paolo Nason,
  Università degli Studi di Milano Bicocca, Milan, 15/09/2022-16/09/2022,
- **Scientific Visit**,
  University of Oxford, Oxford, 25/09/2022-30/09/2022.

Publications

- *Soft Logarithms in Processes with Heavy Quarks*, Journal of High Energy Physics volume 2022, arXiv:2207.13567, Authors: D. Gaggero, A. Ghira, S. Marzani, G. Ridolfi

Abstract: Observables involving heavy quarks can be computed in perturbative QCD in two different approximation schemes: either the quark mass dependence is fully retained, or it is retained only where needed to regulate the collinear singularity. The two schemes have different advantages and drawbacks. In particular, it is known that the structure of large logarithms arising from soft emissions is different in the two approaches. We investigate the origin of this difference in some detail, focussing on a few specific processes. We show that it is related to the non-commutativity of the small-mass and soft-emission limits. Finally, we perform the resummation of soft-emission logarithms to next-to-leading accuracy in the case of Higgs decay into a $b\bar{b}$ pair, in the scheme in which the quark mass dependence is fully accounted for.