Dipartimento
Fisica

UNIVERSITÀ
DI TORINO

Dr. Emanuele R. Nocera
Associate Professor
Department of Physics
Università degli Studi di Torino
& INFN sezione di Torino
Via Pietro Giuria 1
20125 Torino – Italia
Telephone: +39 011 670 7250
E-mail: emanueleroberto.nocera@unito.it

**Report on Tetiana Yushkevych's Ph.D. Thesis**

The Ph.D. Thesis by Tetiana Yushkevych consists of two parts. In the first part, she applies the multi-particle field method to construct a model that aims at describing multi-quark scattering processes. In particular, she considers the elastic scattering cross section as a function of the squared momentum transfer. The computation is performed including spin effects, and it incorporates leading-loop diagram contributions, the computation of which is approximated by means of the Laplace method. A comparison between theoretical predictions and experimental measurements reveals that the model is capable of capturing the qualitative shape of the data, although it generally overshoots it by a significant amount. In the second part, she extends an existing Bayesian statistical tool, called affinity, to characterise the transition across kinematic regions where different factorisation theorems apply. In particular, she considers single-inclusive hadron production in deep-inelastic scattering and compares predictions obtained when kinematic quantities are computed as averages over kinematic bins or reconstructed from bin-by-bin events. The analysis is specifically deployed within the JLab 12 and 22 GeV experimental setup. She finds that the affinity leads to different conclusions in the two cases, with the bin-by-bin event reconstruction allowing for a neater separation of the target fragmentation region than what was originally concluded.

The structure of the Thesis is as follows.

- **Chapter 1** presents an outline of the Thesis structure, and clarifies the relevance of the research topics, the methods used to pursue them, the scientific goals sought in the Thesis, their novelty, and the personal contribution of the candidate to the research work.
- **Chapter 2** presents the theoretical framework and the literature background which the aforementioned topics build upon. The chapter is divided into two parts: one devoted to factorisation theorems in quantum chromodynamics, which form the basis to develop the affinity tool; and one devoted to Reggeisation and to the multi-particle field model, which form the basis to develop the computation of the elastic cross section.
- **Chapter 3** presents the details of the computation of the elastic cross section as a function of the momentum transfer with spin effects. A description of the Laplace method to approximate the computation of leading-loop contributions is also laid out. Detailed comparison between theoretical predictions and experimental data are presented.
- **Chapter 4** presents a discussion on the affinity tool and on its relevance to describe kinematic regions for single-inclusive hadron production in deep-inelastic scattering where different factorisation theorems apply. Results obtained when kinematic quantities are computed as averages over kinematic bins or reconstructed from bin-by-bin events are compared for the JLab 12 and 22 GeV experiments.
- **Chapter 5** presents a summary of the key findings and an outlook.

The Thesis is generally well written. In my opinion, it contains an amount of original work commensurate with the duration of the candidate's Ph.D. studies. Part of the candidate's results have already resulted in a couple of publications, which concern in particular the multi-particle field model. I expect the results on the affinity tool, when published, to have a significant impact in the community of reference. That being said, I found that the first version of the Thesis may benefit from some amendments. I have directly provided the candidate with a detailed list of comments, suggestions, and questions. I trust the candidate to address those that she deems relevant, and to be able to provide clarifications during her Ph.D. defense. All in all, I consider that Tetiana Yushkevych qualifies to receive the Ph.D. degree in Physics.

Torino, 19 August 2025

Emanuele R. Nocera

Università degli Studi di Torino
Dipartimento di Fisica
Via Pietro Giuria 1 – 20125 Torino (IT)
☎ +39 011 670 7250 ✉ emanueleroberto.nocera@unito.it