



Candidate (first name – last name): Tetiana Yushkevych

Title of the Thesis: Perturbative and non-perturbative aspects of hadronic physics

Supervisors (first name – last name): Ihor Sharf, Mariaelena Boglione

Name of the reviewer: Cristian Pisano

Reviewer's institution: University of Cagliari

Please rate the following points

	Insufficient	Sufficient	Good	Excellent
Overall scientific merit (originality, relevance, completeness)			X	
Introduction and bibliography (sufficient information provided by the introduction, appropriate cited references)				X
Methodology (clearly described methods, adequate and exhaustive data analysis (if applicable))				X
Results (convincing and clearly presented results, adequate number and quality of tables and figures)			X	

Overall evaluation (please check one)

- The candidate can be admitted to the final examination**
- The candidate can be admitted to the final examination but the thesis requires minor revision; further evaluation by the reviewer is not required**
- To be admitted to the final examination the thesis requires extensive revision; the revised version must be provided within 6 months and must be re-evaluated by the reviewer**

Specific comments and suggestions [mandatory]

Tetiana Yushkevych's PhD thesis addresses two complementary topics in hadronic physics. The first one, covered in Chapters 2 and 3, deals with a phenomenological model of elastic proton-proton and proton-antiproton scattering amplitudes, based on the method of multiparticle fields, which turns out to be superior to the simple parton model in the description of some qualitative features of the available experimental data, such as the non-monotonic dependence of the cross sections on the momentum

transfer squared. The other topic, discussed in Chapter 4, is the development of a new affinity-based methodology to analyze the transition between the transverse momentum dependent (TMD) and the collinear factorization regimes in semi-inclusive deep inelastic scattering (SIDIS).

I believe that the physical content of this thesis is at the forefront of hadron physics. Its most innovative aspect, within the investigation of elastic scattering, is the use of the Laplace method to approximate loop diagrams. Concerning the study of the SIDIS process, the main result is represented by the new event-by-event approach, which preserves the correlations among non-perturbative parameters, leading to more reliable kinematic classifications as compared to the older bin-averaged methodology. In particular it turns out that, in the accessible kinematic region of the JLab12 experiment, the TMD region is substantially broader than previously estimated. Moreover, at JLab22 energies, the collinear region seems to be narrower but well accessible and the presence of clearly identifiable TMD-collinear matching region would offer the unique opportunity to study the transition between the two factorization regimes.

The thesis is well-written, and both the theoretical derivations and the numerical computations are very accurately described. The results are valuable for obtaining a better theoretical understanding of the structure of the proton and hard scattering processes. They also have much relevance for the experimentalists and for comparisons to their data at facilities such as COMPASS at CERN, as well as Jefferson Lab and the future Electron-Ion Collider (EIC) in the US. I only have a few minor remarks, mainly typos, that hopefully could help in improving the quality of the presentation. They are given in a separate list to be sent to the candidate.

In conclusion, I highly recommend Tetiana Yushkevych's thesis for acceptance in view of the final exam. The content of new physics, the quality of the results and their interest for the hadron physics community certainly fulfill the criteria required for a PhD thesis.

Date and Signature

28/08/2025

Cristian Pisano

