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Supervisor's review of Master Thesis of Bc. Josef Bobek
Thesis title "Jet energy loss in relativistic heavy-ion collisions
with realistic medium modelling"

The master thesis of Bc. Josef Bobek is devoted to a study of state-of-the-art approaches to both medium and jet modelling in relativistic heavy-ion collisions at the energies of Large Hadron Collider. As the LHC enters precision era, it is becoming understood that precise modelling of the evolution of medium created in heavy-ion collisions is important for quantitative description of jet energy loss, and consequently the properties of jets reconstructed in heavy-ion collisions. Medium and jet modelling has evolved into multi-component frameworks, and arguably the most sophisticated and comprehensive framework existing now is JETSCAPE. Study of theoretical foundations and the structure of the framework is a task on its own.

The thesis is divided into 4 main chapters, an introduction, conclusions and 3 appendices. The latter contain supplementary physics information, technical details of simulations and auxiliary plots which did not fit into the main part of the thesis. The chapters are further divided into subchapters for a more structured presentation. The structure of the thesis is clear, the presented material is well-referenced. The thesis has a good flow and reads well.

Chapter 2 of the thesis is devoted to the general description of the Standard Model of particle physics, and concludes with a conceptual issue with its application to heavy-ion reactions, which leads to the use of effective models to describe the hadron production at low transverse momentum, described in the next chapter. Chapter 3 describes an extensive overview of approaches to model different stages of medium evolution in heavy-ion collisions: initial state models, relativistic fluid dynamical approach and inputs to it (equation of state and transport coefficients), and final-state interactions. Chapter 4 is devoted to the formalism of jet production, starting from elementary (proton-proton) collisions and continuing to jet evolution in the presence of dense medium.

Practical results of the thesis are described in Chapter 5. JETSCAPE framework has been set up to simulate production of jets in proton-proton (to be used as a reference) and lead-lead collisions at the two LHC energies, as well as low-transverse-momentum hadrons in the lead-lead collisions. The original task was to investigate to what extent a simplified static and homogeneous

medium of fixed length can be used as an approximation to a realistic inhomogeneous and expanding medium. The task has a relevance to contemporary jet studies, as several theory groups use static and homogeneous medium to compute jet energy loss in heavy-ion collisions. From the side of JETSCAPE framework, that required some bug fixes and interaction with the authors of the framework, which Josef did enthusiastically.

The thesis does not have an overlap in terms of results with the research task (výzkumný úkol) of Josef. The results of the latter are published on arXiv in a pre-print 2205.05358.

In my opinion, the thesis is well-written and Josef spared no efforts to make it extensive. Throughout the master program, Josef showed a good degree of enthusiasm in the topic, worked systematically and independently, and most importantly, showed a very good understanding of the physics behind the jet and medium modelling in heavy-ion collisions. Therefore, I grade this master thesis with an **A (excellent)**.

Dr. Iurii Karpenko



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