Review of the thesis „Low-x QCD studies using Balitsky-Kovchegov equation” by Dagmar Bendova.

The dissertation thesis by Dagmar Bendova is studying hadronic structure at low momentum fractions (low-x) using the Balitsky-Kovchegov (BK) equation. The first chapter of the thesis is a very nicely written overview of phenomena measured in deep inelastic scattering (DIS) which motivates low-x physics. The second chapter discusses the hot spot model, which is a model aiming at the description of fluctuating nature of proton structure. This chapter contains also original results studying the so-called geometrical saturation. Chapter 3 provides an overview of current issues connected with the BK equation (the issues of choice of initial conditions; use of the running coupling; various definitions of the kernel; the NLO accuracy; and the impact parameter (b) dependence of BK equation). This chapter contains the original results by the author of the thesis where the BK with collinear improved kernels is used to calculate structure functions measured at HERA. Numerical solutions to b-dependent BK equation for various processes and their comparison with the data or predictions for future experiments are provided in Chapter 4. These processes are diffractive DIS, deeply virtual Compton scattering, and exclusive production of vector mesons. The last chapter presents work on numerical solutions of the NLO b-dependent BK equation and the problem of large negative terms present in this NLO solution.

The thesis presents original results of high quality. Results were published in five articles in international journals of very high quality. The problem of the low-x structure of hadrons and saturation of gluon distribution functions is one of the very important open problems connected with the strong interaction. The results presented in this thesis certainly bring an important contribution to understanding this problem. In particular, results narrow down the possible sources of the negative terms present in solutions of the NLO BK equation which is certainly very important. Providing a large set of comparisons of calculations with existing data and a large set of predictions that are shown to have clear discriminative power is also very important.

The thesis is well written. There are a minimum of typos and only a few places where the text could be fixed or improved. Here I provide some of these places for the case that the author would want to further work with the text:

- page 9: the sentence “… were supposed to be massless …” mixes past tense and present tense
- page 12: would be good to describe the equation by introducing the term singlet distribution functions
- page 65: reference to an equation is missing
- page 43: coulomb tails should be defined / explained earlier since you already spoke about them
- Typos: page 24: In the work, page 27: of the linear behavior, page 31: sizes of the dipole size

In general, there is no doubt about the quality of the presented work. Nevertheless, I'd like to ask several questions and I'd like to kindly ask the author of the thesis to prepare answers for a discussion during the defense of the thesis:

a) Does the geometrical saturation discussed in the thesis have some impact on the gluon saturation due to gluon fusion?

b) Is it possible to put forward some simple arguments explaining why the cross-section for the dissociative production of vector mesons can be calculated as a variance over different geometrical configurations?

c) In Sec. 3.3, you discuss the alpha_s as a function of the number of flavors. For alpha_s(Q^2), flavors are active depending on Q^2, and thus their number changes as a function of Q^2, which then changes the value of alpha_s in steps. How does it work for alpha_s(r)? Is there some threshold matching procedure applied to avoid steps in alphas(r)? How is it done, please?

d) What is the reason for the absence of the diffractive minimum for the IP-nonSat model? Is it present at some higher |t| value or is it absent? Does the minimum have a common origin in all the models?

e) BK equations are formulated in the large Nc limit. How does this inaccuracy of the description of the real strong force influence the results? Is it possible to go beyond this limit?

f) Is the Ksub term contribution to NLO incorrect? Or does it point to some larger problem? What is the perspective for addressing the problem of large negative terms in the NLO?

Irrespective of the above-given comments, I would like to stress that the thesis is of high quality and I can certainly recommend this thesis as a valid dissertation thesis.

doc. Mgr. Martin Spousta, Ph.D.
ÚCJF, MFF UK