Project for the JINR University Center

Title

QCD analysis of the DIS structure functions and the analytic approach

Description of the project

The investigation of deep inelastic scattering (DIS) of leptons on the nucleon is an important tool to get fundamental information on the internal structure of the nucleon (see [1, 2]). In order to get information on the quark distributions in the nucleon, it is necessary to have theoretical control over power corrections, such as the dynamical power corrections (or high twist effects) and target mass corrections (TMC). The operator product expansion method was first used to study target mass effects by Georgi and Politzer [3]. This an approach for considering TMC became known as the Georgi – Politzer (GP) approach or ξ-scaling method because it was formulated in terms of the Nachtmann ξ variable. However, the expressions for the structure functions obtained by using the ξ-scaling method have a difficulty arising from the violation of the spectral condition (see [4] as review). New solution of this problem was proposed in the framework of the Shirkov–Solovtsov analytic approach [5] which was later generalized to more complicated objects, such as structure functions (see [6] as review). For the inelastic lepton-hadron scattering process, the general principles of the theory are accumulated in the Jost–Lehmann–Dyson (JLD) integral representation. The proof of the JLD representation is based on the most general principles of the theory, such as the covariance, Hermiticity, spectrality, and causality.

The purpose of the project research is to perform the QCD analysis of the experimental data on the DIS structure functions based on the analytic approach to improve the shape of the higher twist contribution and parton distributions, and to study the role the target mass corrections at kinematics region at low Q^2 [7,8].

Students shall possess knowledge of the theoretical analysis of experimental data on deep-inelastic scattering of leptons on nucleons, in the framework of the standard Georgi–Politzer method and its generalizations on the basis of analytic approach proposed by Shirkov–Solovtsov.

Description of the work for students:

Study of the methods of the description of Q^2-evolution of the structure functions, analysis of the contribution of power and mass corrections, methods of comparison of the theory predictions for Q^2-evolution to the experimental data on structure functions.

Results of the project will be presented in the form of the report and could be

consider as a basis of the scientific publication.

Acceptance criteria

The student assumes a basic knowledge of quantum field theory, programming skills, mastering the program Mathematica, Mathcad, Origin.

Recommended literature

1. F.J. Indurain, ``*The Theory of Quark and Gluon Interactions"* (Springer-Verlag Berlin Heidelberg 1993, 1999, 2006).
2. R.G. Roberts, ``*The Structure of the Proton: Deep Inelastic Scattering"* (Cambridge Univ. Press, Cambridge, 1990).
3. H. Georgi, H.D. Politzer, ``*Freedom at Moderate Energies: Masses in Color Dynamics"*, Phys. Rev. D **14**, 1829 (1976).
4. I. Schienbein *et al.*, ``*A Review of Target Mass Corrections"*, J. Phys. G **35**, 053101 (2008).
5. D.V. Shirkov, I.L. Solovtsov, ``*Analytic model for the QCD running coupling with universal $a_s(0)$ value*", Phys. Rev. Lett. **79**, 1209 (1997).
6. D.V. Shirkov, I.L. Solovtsov, ``*Ten years of the Analytic Perturbation Theory in QCD"*. Theor. Math. Phys. **150**, 132 (2007).
7. A.V. Sidorov, D.B. Stamenov, ``*Target Mass Effects in Polarized Deep Inelastic Scattering*", Mod. Phys. Lett. **21**, 1991 (2006).
8. O.P. Solovtsova, V.I. Lashkevich, ``*The Jost-Lehmann-Dyson representation and target mass effects",* Teor. Mat. Fiz. **160**, 471 (2009).
9. J. Blumlein,``*The Theory of Deeply Inelastic Scattering",* Prog. Part. Nucl. Phys. **69,** 28 (2013).

The expected number of participants of the project

The number of the participants is 2-3 students from South Africa and Belarus (in the period from 08 September to the 26th of September).

The project coordinators from the JINR

Bogoliubov Laboratory of Theoretical Physics, ``Theory of Fundamental Interactions" ,

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