Iterative Solution of DGLAP Equations in QED

Andrej Arbuzov[1,2] and Uliana Voznaya[1,2]

[1] *Bogolyubov Laboratory of Theoretical Physics, JINR, Dubna, Russia*

[2] *Dubna State University, Dubna, Russia*

An iterative solution of the Dokshitzer–Gribov–Lipatov–Altarelli–Parisi evolution equations in QED is realized in the FORM programming language [1]. Perturbative solutions for unpolarized QED parton distribution and fragmentation functions are presented explicitly in the next-to-leading logarithmic approximation [2]. The results are presented in terms of harmonic polylogarithms evaluated with the help of Mathematica package [3].

The obtained electron fragmentation functions are applied to calculation of higher-order QED radiative corrections to muon decay spectrum within the next-to-leading order logarithmic approximation. New analytical results are given in the $\mathcal{O}(\alpha^3 \ln^2(m_\mu^2/m_e^2))$. Earlier results in $\mathcal{O}(\alpha^2 \ln^1(m_\mu^2/m_e^2))$ and $\mathcal{O}(\alpha^3 \ln^3(m_\mu^2/m_e^2))$ orders are partially corrected.

The electron parton distribution functions are used to caculate initial-state radiative corrections to a general electron-positron annihilation process. Analytic results are presented [5] in the orders up to $\mathcal{O}(\alpha^4 \ln^3(s/m_e^2))$ where s is the square of the total energy in the center of mass system. These results are relevant for experiments at future electron-positron colliders including Super Charm-Tau Factory, CEPC, and FCC-ee.

Acknowledgement. This work was supported by the Russian Science Foundation, project No. 22-12-00021.

References

[1] J. Kuipers, T. Ueda, J. A. M. Vermaseren, and J. Vollinga, *Computer Physics Communications* **184** (2013), 1453-1467.

[2] A. B. Arbuzov and U. E. Voznaya, *Journal of Physics G* **50** (2023) 125004.

[3] D. Maitre, *Computer Physics Communications* **174** (2006) 222–240.

[4] A. B. Arbuzov and U. E. Voznaya, *Physical Review D* **109** (2024) 053001.

[5] A. B. Arbuzov and U. E. Voznaya, *Physical Review D* **109** (2024) 113002.