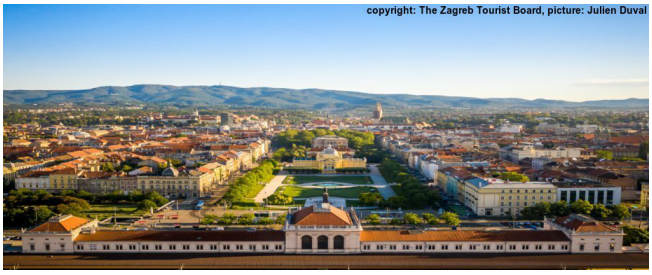

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Z-boson decay at the NNNLO level.

Friday 16 July 2021 11:00 (30 minutes)

The study of the Z-boson decay was crucial for the success of the LEP experiment. In e^+e^- collisions, with the centre of mass energy matched to its mass, i.e. $\sim$ 91 GeV, around 17 million Z-bosons were produced. Significant statistics allowed for precise measurements of its decay products along with the Standard Model (SM) parameters. The precision of LEP was so high that quantum corrections had to be taken into account, proving the correctness of the SM as a quantum gauge theory.

The Future Circular Collider in its lepton mode (FCC-ee) is one of the next-generation colliders along with ILC, CLIC and CEPC, which will improve the statistics immensely. Operating at the Z resonance, it will be able to produce 10^{12} Z-bosons and it will lead to at least one order of magnitude smaller experimental uncertainties of the electroweak observables (e.g. the Z-boson decay width).
These enormous statistics is a challenge for theory. Expected experimental errors are one to two orders of magnitude smaller than current theoretical errors, and more precise theoretical calculations are needed to meet experimental demands. It means that the complete 3-loop electroweak corrections to the Z-boson decay are highly needed.

The complexity of the problem will be discussed along with the state of the art methods. Picking up the most difficult NNNLO (next-to-next-to-next-to-leading order) Z-boson diagrams, we show that recently improved calculational methods allow achieving desired NNNLO precision. The talk is an extension of the latest articles [1,2].

[1] I. Dubovyk, J. Usovitsch, K. Grzanka, Toward three-loop feynman massive diagram calculations, Symmetry 13 (6) (2021). doi:10.3390/sym13060975. URL https://www.mdpi.com/2073-8994/13/6/975

[2] I. Dubovyk, A. Freitas, J. Gluza, T. Riemann and J. Usovitsch,
"Electroweak pseudo-observables and Z-boson form factors at two-loop accuracy",
JHEP08 (2019), 113, doi:10.1007/JHEP08(2019)113.

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