Contribution ID: **55** Type: **not specified**

High precision calculations for the MUonE experiment

Wednesday, 15 February 2023 15:30 (20 minutes)

The muon anomalous magnetic moment $= (-2)/2$ has been measured at Brookhaven National Laboratory in 2001 and, more recently by the Fermilab Muon ☒–2 Experiment. Their results deviate by $4.2\ \sigma$ from the Standard Model theoretical predictions. The largest source of theoretical error is the Hadronic Leading Order (HLO) contribution ☒☒☒. This contribution can be calculated using dispersion relation techniques together with $^{+-} \to hadrons$ timelike data. Moreover, recently, ☒☒☒ has been also calculated using Lattice QCD techniques and their results seem to be in disagreement with the timelike determination. Thus, a third independent calculation for ☒☒☒ would be useful to understand the nature of the discrepancy of -2: in this respect, MUonE is a proposed experiment at CERN whose aim is to provide a new and independent determination of ☒☒☒ in the \textit{spacelike} region using muon-electron scattering at low momentum transfer. The MUonE experiment has a target accuracy of about 10 parts per million on the differential cross section, so that the error on ☒☒☒ is comparable with the timelike error. Hence, also the theoretical prediction of the differential cross section has to reach the same level of precision. A very precise calculation of the muon-electron scattering cross section with all the radiative corrections and backgrounds is required.
In this talk, the theoretical formulation for the NNLO photonic contributions and the NNLO real and virtual lepton pair contributions to scattering are described. Numerical results, obtained with a fully differential Monte Carlo event generator, are shown. Such contributions are essential to reach the precision needed for the MUonE experiment.

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Session Classification: Young Researchers Session