MITP workshop

The Evaluation of the Leading Hadronic Contribution to the Muon $g-2$: Toward the MUonE Experiment

Report from the N^{3}LO Workstop

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physical $2 \to 2$ cross section

$$\sigma = \int \mathrm{d}\Phi_2 \left| \quad + \quad + \quad + \quad + \cdots \right|^2$$

$$+ \int \mathrm{d}\Phi_3 \left| \quad + \quad + \quad + \cdots \right|^2$$

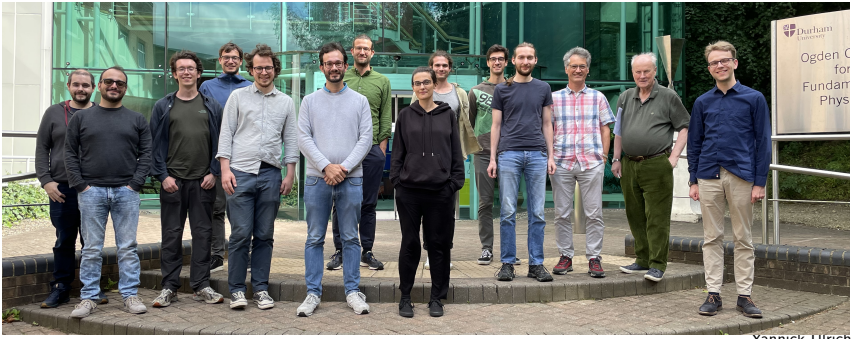
$$+ \int \mathrm{d}\Phi_4 \left| \quad + \quad + \cdots \right|^2$$

$$+ \int \mathrm{d}\Phi_5 \left| \quad + \cdots \right|^2$$

-  $\sim$ three-loop heavy quark form factor $\rightarrow$ Matteo's talk
-  $\sim$ really difficult, see later
-  $\sim$ OpenLoops$\oplus$NTS stabilisation $\rightarrow$ nasty but doable
-  $\sim$ tree level but difficult phase space $\rightarrow$ (hopefully) easy enough
- $\int \mathrm{d}\Phi_5 \left| \cdots \right|$ $\sim \mathrm{FKS}^3$ subtraction

small workstop in Durham (3 – 5 Aug)

- VVV: Lange, Schönwald, Fael
- RVV: Ronca, Moodie
- RRV: Lindert, Schär
- assembly & dirty tricks: Engel, Rocco



the most difficult part: four scales (m, Q^2, s_{12}, $s_{1\gamma}$)

using approximations

- massless integrals known (three-jet @ NNLO)
- massification, NTS stabilisation, jettification

\+ fast evaluation (fully analytic), stable by construction, not too difficult

– introduces difficult-to-quantify systematic error

using brute-force

- numerical evaluation of full integrals (eg. DiffExp)

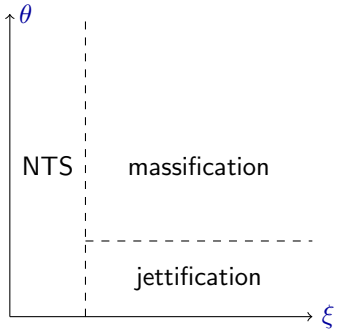
$\Rightarrow$ need to find master integral basis (KIT group)

\+ no new systematic error

– slow evaluation, potentially very unstable, extremely difficult

the most difficult part: four scales (m, Q^2, s_{12}, $s_{1\gamma}$)

using approximations



using brute-force

- starting point: $\dfrac{\mathrm{d}\vec{F}}{\mathrm{d}x_i} = A_i\vec{F}$
- know integrals at some point (eg. boundary conditions)
- find a line to where you want it $0 < y < 1$
- solve $\mathrm{d}\vec{F}/\mathrm{d}y = A_y\vec{F}$ using power series in y
- repeat
- highly efficient implementation in DiffExp [Hidding 20]

- the N^3 LO calculation will be very difficult
- ... but it will be doable for the dominant corrections
- ... using all the tools

$\Rightarrow$ whitepaper will be written to demonstrate this to the community

$\Rightarrow$ provide input for Strong2020 Workstop in Zurich (Summer 23)